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SUSTAINABILITY AND CLIMATE CHANGE: THE ROLE OF EDUCATION IN TECHNICAL TRAINING AND POSTGRADUATE STUDIES IN BRAZIL

SUSTENTABILIDADE E MUDANÇAS CLIMÁTICAS: O PAPEL DA EDUCAÇÃO NA FORMAÇÃO TÉCNICA E NOS ESTUDOS DE PÓS-GRADUAÇÃO NO BRASIL

MARECHAL CÂNDIDO RONDON

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Doctoral Thesis presented to the Graduate Program in Sustainable Rural Development of the Center for Agricultural Sciences at UNIOESTE – State University of Western Paraná, as a partial requirement for obtaining the degree of Doctor in Sustainable Rural Development. Advisor: Prof. Dr. Alessandra Matte.

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LIST OF ABREVIATIONS

ASDG	Awareness of the SDGs
CAET	Colégio Agrícola Estadual de Toledo
CC	Climate Change
CCE	Climate Change
GEN	Gender
IBAMA	Brazilian Institute of environment (Instituto Brasileiro Meio Ambiente)
KSDG	Knowledge of the SDGs
NGO	Non-Governmental Organization
PRONAF	Programa Nacional de Fortalecimento da Agricultura Familiar
REL	Religion
RXU	Rural x Urban
SD	Sustainable Development
SDG	Sustainable Development Goals
SRD	Sustainable Rural Development
TTE	Technical and Technological Education
UN	United Nations
TVET	Technical and Vocational Education and Training
IPCC	Intergovernmental Panel on Climate Change
EPT	Educação Profissional e Tecnológica (Professional and Technological Education)
IPARDES	Instituto Paranaense de Desenvolvimento Econômico e Social (Parana Institute for Economic and Social Development)
GDP	Gross Domestic Product
UNESCO	United Nations Educational, Scientific and Cultural Organization
LDB	Lei de Diretrizes e Bases da Educação Nacional (Law of Guidelines and Bases of National Education)
NGO	Non-Governmental Organization
VTE	Vocational and Technical Education
IFMT	Instituto Federal de Mato Grosso (Federal Institute of Mato Grosso)
ODS	Objetivos de Desenvolvimento Sustentável (Sustainable Development Goals)

CO2	Carbon Dioxide
CH2	Methane
N2H	Nitrous Oxide
FAO	Food and Agriculture Organization
GHG	Greenhouse Gas
P	Phosphorus
N	Nitrogen

SUMMARY

OVERALL INTRODUCTION

In an era defined by unprecedented environmental challenges and the urgent need for sustainable development, the intersection of technical and technological education in agriculture emerges as a pivotal nexus for addressing pressing global issues. With the Sustainable Development Goals (SDGs) as a guiding framework, the imperative to decrease climate change and promote sustainable agriculture has never been more crucial.

At the heart of this imperative lies the role of education in equipping individuals with the knowledge, skills, and mindset necessary to navigate complex environmental and agricultural landscapes. Sustainable agriculture is a key piece in the puzzle of global sustainable development. As the world faces increasingly complex challenges such as climate change, natural resource scarcity, and growing food demand, it becomes imperative for professionals in the field of agriculture to have a solid foundation in sustainable agricultural practices.

Historically, agricultural education has focused primarily on technical skills and knowledge related to crop production, animal husbandry, and farm management. However, as the environmental and social impacts of conventional agricultural practices have become increasingly apparent, there has been a growing recognition of the need to incorporate sustainability principles into agrarian education (Brown & Majumdar, 2020). This shift reflects a broader paradigmatic change within the agricultural sector (Kastrup & Winzier, 2013), emphasizing the importance of adopting holistic and environmentally conscious approaches to farming practices.

The need for holistic (J. F. L. e Silva & Silva, 2022) and interdisciplinary approaches (Klaassen, 2018; Méndez & Gliessman, 2002; Rodrigues, 2016) in agricultural education, integrating scientific, social, and economic perspectives (Sachs, 2008) to provide a comprehensive understanding of sustainability and climate change issues (Machado & Davim,

2023) is paramount. This approach helps students grasp the interconnectedness of these challenges and fosters a sense of responsibility towards sustainable development (Kioupi & Voulvoulis, 2019).

While considerable research has delved into the worldwide implications of the SDGs and strides have been taken to measure their progress (Sachs et al., 2021, 2023) being the most complete ones; there is a growing recognition of the imperative to prioritize localized viewpoints, particularly in rural areas (Klekotko et al., 2018).

The central thesis connecting the three articles in this adventure that you are about to embrace, revolves around the importance of integrating sustainability and climate change education within educational systems, and therefore the sustainable development goals (which are the bare minimum that we should be doing) especially regarding future educators, in this case advanced students in rural development fields and technical and technological education students. This approach might arm future professionals with the knowledge and skills necessary to address unsustainable agricultural practices and the challenges posed by the (very real and man-made) climate change (IPCC, 2022a).

This echoes the age-old mantra Think globally, act locally, often attributed to Patrick Geddes, (Meller, 2005). As a teacher, professor and human (trying to think globally and act locally) (and here I break the third wall in this introduction), I come from the conception that something is broken in the chain of teaching. Something is being lost between what comes from our lesson plans and what is going to our students' conceptions and world views, and it might be ending up in the same parallel reality that our pen caps are ending in. So, I ask you to ponder on this question, Is it a generation gap among us (millennials) and generation x? Or is it a gap in the way we are trying to teach them about sustainability? While your subconscious obsesses about it, let us return and add some more academically inclined questions that drove this research.

How are sustainability principles integrated into the curriculum of agrarian technician training programs at the State Agricultural College of Toledo (CAET)? What are the perceptions and knowledge levels of students regarding sustainability and climate change in the context of their agricultural education? What are the perceptions and knowledge levels of students regarding sustainable development goal and climate change in the context of advanced students? What are the main challenges and gaps in the current approach to teaching sustainability within the CAET curriculum? How do different teaching methods (e.g., practical classes, dialogical lessons) impact students' understanding and application of sustainability principles? What improvements can be made to enhance the integration of sustainability education in agrarian training programs to better prepare students for sustainable agricultural practices?

In this thesis we hypothesize that incorporating sustainability principles into agrarian education curricula will enhance students' understanding and commitment to sustainable agricultural practices. By explicitly teaching these concepts and providing practical examples, students will be better equipped to implement sustainable practices in their future careers, but first we must equip our teachers with this knowledge.

Despite the critical importance of sustainability in agriculture, there is a significant gap in the effective integration of sustainability and climate change education within agricultural training programs. This gap limits the ability of future agricultural professionals to effectively address the complex challenges posed by environmental degradation and climate change.

That said, the purpose of this study is to explore and evaluate the integration of sustainability and climate change education within the curriculum of agricultural training programs at the State Agricultural College of Toledo (CAET) in Paraná, Brazil. To understand how sustainability principles are incorporated into the education of agrarian technicians and

advanced students, and how these principles influence their perceptions, knowledge, and practical application of sustainable agricultural practices.

Specifically, the study seeks to identify the strengths and gaps in the current curriculum related to sustainability education, examine students' understanding and perceptions of sustainability concepts, and assess the effectiveness of different teaching methods in conveying these principles. By doing so, the research aims to provide insights into how sustainability education can be enhanced to better prepare students for the challenges of modern agriculture, particularly in the context of environmental and socio-economic changes.

Ultimately, the study aims to contribute to the broader efforts of promoting sustainable rural development by informing curriculum development, teaching strategies, and policy decisions in agricultural education. By addressing the educational gaps and enhancing the integration of sustainability principles, the study aspires to prepare future agricultural professionals who are well-equipped to lead and implement sustainable practices, ensuring the long-term resilience and viability of agricultural systems.

This study holds significant value for multiple stakeholders, including educational institutions, policymakers, and the broader agricultural community. By providing a detailed examination of how sustainability and climate change education are integrated into the curriculum at the State Agricultural College of Toledo (CAET), the research offers insights that can enhance the quality and effectiveness of agrarian training programs.

The findings will inform curriculum developers and educators about the current strengths and gaps in sustainability education. By identifying effective teaching methods and highlighting areas needing improvement, the study can guide the development of more comprehensive and impactful educational strategies. This can lead to the preparation of students who are not only knowledgeable about sustainability but also capable of implementing sustainable practices in their professional careers.

The study provides evidence-based recommendations that can influence educational policies and funding priorities. Policymakers can use these insights to support initiatives that promote sustainability education, ensure that agrarian training programs are aligned with environmental and socio-economic goals, and foster a generation of agricultural professionals who are equipped to address the challenges of climate change and environmental degradation.

By equipping future agricultural professionals with a robust understanding of sustainable practices, the study contributes to the broader efforts of promoting sustainable rural development. Well-trained professionals can lead innovations and practices that enhance the resilience and productivity of agricultural systems, ensuring long-term food security and environmental health.

Enhancing climate change education within educational programs will increase students' awareness and understanding of climate change impacts, leading to more proactive attitudes and behaviors towards climate mitigation and adaptation. This approach aims to cultivate a generation of informed and engaged professionals (either teachers or technicians) ready to address climate-related challenges. These knowledge areas should not be restricted to people that are interested in environmental fields; it should be taught to all that are yet to survive.

The thesis is structured around three core articles, each contributing to a comprehensive understanding of the current state and future directions of agricultural education: In the first article, the integration of sustainability principles within the curriculum of the Agricultural Technician program at the State Agricultural College of Toledo (CAET) in Paraná, Brazil, was explored. The study juxtaposed the curriculum's focus with students' perceptions of sustainability discussions across different disciplines.

In “Sowing the Seeds of Sustainability: The Curriculum Shift in Agrarian Technician Training”, the incorporation of sustainability principles within the curriculum of the

Agricultural Technical Vocational Education and Training (TVET) program at CAET is observed. In the article we examine students' perceptions of sustainability across various disciplines and highlight the gaps between the curriculum's intentions and its practical implementation.

The second article in the study, delved into the perspectives of students enrolled in rural studies regarding the Sustainable Development Goals (SDGs) across two distinct educational cohorts: high school agricultural vocational education and training students, and advanced students in master's and doctorate degrees in sustainable development. In the final article we seek for a light in the end of the tunnel, by looking into the wisdom and ingenuity of those who tilled the soil and cultivated the future, our study aimed to uncover perceptions of climate change and their mitigation and adaptation strategies.

The articles collectively emphasize the significance of integrating sustainability principles into agricultural education, understanding student perceptions of climate change, and identifying the challenges in educational practices. Firstly, the integration of sustainability principles into the curricula of agrarian educational programs is highlighted as essential for preparing students to face real-world agricultural challenges. This involves both theoretical understanding and practical applications, aiming to foster holistic and environmentally conscious approaches in future agricultural practices.

Secondly, the articles delve into the perceptions and understanding of climate change among students, including those in high school agricultural technician programs and advanced rural development courses. These studies explore students' awareness of climate change impacts and their views on sustainable practices, underscoring the importance of education in enhancing climate literacy and fostering proactive attitudes towards climate change mitigation and adaptation.

Lastly, the need for a paradigm shift in traditional educational approaches is emphasized. The articles point out the necessity for innovative educational strategies to integrate sustainability into all aspects of agricultural training, addressing the current lack of interdisciplinary approaches in conventional academic settings.

OVERALL METHODOLOGY

The State Agricultural College of Toledo (CAET) was selected for this study due to its prominent role in agricultural education in the region of Toledo, Paraná in the south region of Brazil. As a specialized institution focusing on TVET agricultural sciences and technologies, CAET offers a curriculum that integrates both theoretical knowledge and practical skills in agrarian studies.

The college provides an ideal setting for studying sustainability in agriculture due to its emphasis on practical learning experiences and its commitment to environmental stewardship. Additionally, the geographical location of CAET in Toledo, a region known for its agricultural production, provides a relevant context for exploring the relationship between education and sustainable rural development.

After selecting the target school for our research, the next methodological phase focused on the documentary analysis of the course's guiding documents, through the analysis of the course plan documents. The methodology encompasses both quantitative and qualitative data collection methods to provide a comprehensive understanding of students' perspectives.

The study commences with a detailed analysis of the curriculum followed by agrarian technician students, focusing on core and technical subjects related to sustainability. Course materials, syllabi, and academic resources were reviewed to identify specific topics, themes, and learning objectives related to sustainability education.

When examining disciplines that may spark discussions about sustainability, we considered criteria such as the mention of “environmental”, “socioenvironmental”, and “sustainable” adjectives, the relationship with national public policies (including environmental education policy), mentions of urgent issues for students' education, and contemporary issues. Therefore, it is possible to infer that when discussing the presented topics, the approaches

encompass issues related to the environment. Regarding data analysis, it is relevant to highlight that in this study, we applied triangulation, emphasizing the combination of collected data with theory, as suggested by (Yin, 2001). This was done to ensure the validation of facts and phenomena identified during the research.

The research proposes a detailed examination of the curriculum (which can be seen as a case study) and the qualitative analysis of students' perceptions and definitions of sustainability. The case study approach allows for an in-depth exploration of a specific context or phenomenon, in this case, sustainability education within the agrarian TVET. By combining qualitative data collection and analysis methods, such as curriculum analysis and thematic analysis of questionnaire responses, the study seeks to generate rich insights and understandings of the complexities surrounding sustainability education in this particular context.

After completing the documentary research, we developed a comprehensive questionnaire with open-ended, descriptive, and multiple-choice questions, using the Google Forms platform. The main purpose of this form was to obtain a deep understanding of students' perceptions regarding sustainable agriculture and sustainability in general based on the studies of (Aleixo et al., 2021; Hyland et al., 2015; Jones et al., 2024). Through these questions, we sought to capture the perspectives and knowledge of the students on these topics to enrich our analysis and contribute to a more comprehensive view of issues related to sustainable agriculture.

A sample of 242 students was obtained from the questionnaire in appendix 01. Of the students surveyed, 132 (54.3%) are male and 106 (43.6%) female, and 5 (2.1%) were gender non-specific. The age of respondents varies between 15 and 17, but the highest response rate was in the 16 range. Most respondents were in the second grade 125 (51.7%) and 116 (48.3%) were graduating seniors (Third grade).

Out of the questionnaire available in appendix 2, a sample of 248 advanced students was obtained. Of the students surveyed, 143 (57,6%) are female and 105 (42,4%) males. The age of respondents varies between 22 and 64, but the highest response rate was in the 26 range. Most respondents were pursuing their master's degree 128 (51.61%) and 120 (48.39%) their doctorate degrees.

Throughout the study, utmost care was taken to uphold ethical standards. Informed consent was diligently obtained from all participants, with assurances of anonymity, confidentiality, and secure data storage for research purposes. Structured questionnaires with open and closed-ended questions, using the Likert-type scale based on previous work of (DeVellis, 2016; Jamieson, 2005), were administered through the Google Forms tool, a detailed and objective tool for assessments (Komperda, 2017). The data obtained was organized on the platform itself using the online spreadsheet program. Subsequently, with the assistance of R program (R Core Team, 2021) R-Studio (R-studio, 2022), the data underwent descriptive analysis (Komperda, 2017).

Statistical analysis.

By employing a rigorous mixed-methods approach, this study aims to provide valuable insights into TVET agrarian and advanced students' perceptions of the importance of The sustainable development goals. The combination of curriculum analysis and questionnaire survey allows for a comprehensive exploration of students' perspectives, contributing to the ongoing discourse on sustainability education and its implications for agricultural training and practice.

The analysis commenced by calculating descriptive statistics (including mean, median, and standard deviation) separately for each group. This facilitated an understanding of the

distribution and central tendencies of the responses to questions related to SDGs (Maravelakis, 2019).

Descriptive statistics were used to analyze demographic data, including age distribution, gender distribution, religious affiliation, and residential background. The Shapiro-Wilk test was conducted to assess the normality of the data, and non-parametric statistical tests were used due to non-normal distributions.

Participants' awareness and knowledge levels of SDGs were analyzed using descriptive statistics. The Wilcoxon rank sum test was employed to compare awareness and knowledge levels between Agrarian Technician Students and Advanced Students.

Participants were asked to rank the perceived importance of each SDG for the nation's overall welfare on a scale of 1 to 4. Mean scores were calculated to compare the perceived importance levels of SDGs between Agrarian Technician Students and Advanced Students. The Mann-Whitney U test (Wilcoxon rank sum test) was used to analyze the differences in perceived importance levels between the two student cohorts.

Correlation analyses were conducted to explore the relationships between different aspects of sustainable development, including SDGs, awareness, and knowledge levels. Spearman's Rank Correlation was used to identify nonlinear correlations between SDGs and other variables. Correlation matrices were generated to visualize and interpret the strength and direction of relationships among variables.

The correlation matrix emerges as a cornerstone tool, wielding significant influence in uncovering hidden relationships within datasets. By scrutinizing variables and their interplay, researchers gain invaluable insights into the dynamics shaping their data. The correlation matrix serves as a robust mechanism for unveiling the intricate web of connections between variables, facilitating the identification of patterns, trends, and dependencies that might otherwise remain obscured.

The nonparametric Spearman's Rank Correlation analysis was conducted in this study to determine the relationship between each SDG (Spearman, 2010). Since the data are nonlinearly correlated, Spearman's analysis was chosen as it is less sensitive to outliers (Hauke & Kossowski, 2011). The correlation analysis was performed using research data from the questionnaire applied to both students' cohorts regarding the 17 SDGs, their SDG awareness (ASDG), and SDG knowledge (KSDG). These results elucidate the synergies and trade-offs among the SDGs and aid institutions in future planning.

Finally, results were interpreted to identify significant findings and trends in demographic characteristics, awareness, knowledge, and perceptions of SDGs among Agrarian Technician Students and Advanced Students. The implications of the findings were discussed in the context of promoting sustainable development initiatives and educational strategies tailored to the needs of different student populations.

ARTICLE 01 - SOWING THE SEEDS OF SUSTAINABILITY: THE CURRICULUM SHIFT IN AGRICULTURAL TECHNICIAN TRAINING

ABSTRACT

In an era marked by environmental crises and social disparities, the role of education in cultivating sustainable practices within the agrarian sector is paramount. This study investigates the integration of sustainability principles into the curriculum of the Agricultural Technical Vocational Education and Training (TVET) program at the State Agricultural College of Toledo (CAET) in Paraná, Brazil. By comparing the curriculum's focus on sustainability with students' perceptions, this research unveils critical insights into how future agricultural professionals are being prepared for sustainable development. The findings highlight a robust association between agriculture and sustainability, with agriculture being the most frequently mentioned discipline among students, followed closely by agroecology. Other significant disciplines include horticulture, environmental management, and soil science. Despite the curriculum not explicitly linking some disciplines to sustainability, instructors' teaching methods often incorporate these principles. However, a notable gap exists between the perceived importance of sustainability discussions in core disciplines and their actual occurrence, suggesting a need for enhanced integration. Practical, hands-on classes are perceived as the most effective for studying sustainability, followed by dialogical lessons that encourage critical thinking and collaborative learning. Expository lectures, while traditional, are still valued by some students. Seminar presentations and active methodologies are less favored, indicating a preference for more interactive and experiential learning methods. To bridge the gap between the curriculum's intentions and its practical application, it is essential to invest in targeted education and training for teachers. This study emphasizes the importance of a deliberate and holistic approach to

embedding sustainability in agrarian education. By doing so, future professionals will be better equipped with the knowledge and skills necessary to drive sustainable rural development. Interdisciplinary interactions play a crucial role in promoting sustainability education, fostering the integration of diverse knowledge sets and resulting in a more holistic understanding of complex issues. This approach not only enriches the educational experience but also prepares students to address the multifaceted challenges of sustainability in their future careers. Ultimately, this research underscores the critical role of education in shaping the perspectives and actions of future agrarian professionals. Through targeted teacher training and comprehensive sustainability education, institutions can better prepare students to lead in sustainable rural development, ensuring the resilience and viability of agricultural systems for generations to come.

Keywords: Sustainability, Agricultural TVET, Curriculum Integration, Student Perceptions, Teacher Training.

SEMEANDO AS SEMENTES DA SUSTENTABILIDADE: A MUDANÇA NO CURRÍCULO DE FORMAÇÃO DE TÉCNICOS AGROPECUÁRIOS

RESUMO

Em uma era marcada por crises ambientais e disparidades sociais, o papel da educação em cultivar práticas sustentáveis no setor agrário é primordial. Este estudo investiga a integração dos princípios de sustentabilidade no currículo do programa de Educação Profissional Técnica em Agropecuária (EPT) do Colégio Agrícola Estadual de Toledo (CAET) no Paraná, Brasil. Ao comparar o foco do currículo na sustentabilidade com as percepções dos alunos, esta pesquisa revela insights críticos sobre como futuros profissionais agrícolas estão sendo preparados para o desenvolvimento sustentável. Os resultados destacam uma forte associação entre a disciplina agricultura e sustentabilidade, sendo ela a disciplina mais mencionada pelos alunos, seguida de perto pela agroecologia. Outras disciplinas mencionadas incluem horticultura, gestão ambiental e ciência do solo. Apesar de o currículo não vincular explicitamente algumas disciplinas à sustentabilidade, os métodos de ensino dos professores frequentemente incorporam esses princípios. Apesar disso, existe uma lacuna notável entre a importância percebida das discussões sobre sustentabilidade nas disciplinas base e sua ocorrência real, sugerindo a necessidade de aplicação da interdisciplinaridade. As aulas práticas são percebidas como as mais eficazes para estudar sustentabilidade, seguidas por aulas dialógicas que incentivam o pensamento crítico e a aprendizagem colaborativa. Aulas expositivas, embora tradicionais, ainda são valorizadas por alguns alunos. Apresentações de seminários e metodologias ativas são menos preferidas, indicando uma prioridade por métodos de aprendizagem mais interativos e experienciais. Para preencher a lacuna entre as intenções do currículo e sua aplicação prática, é essencial investir na educação e treinamento direcionados para professores. Este estudo

enfatiza a importância de uma abordagem deliberada e holística para incorporar a sustentabilidade na educação, ao fazer isso, os futuros profissionais estarão equipados com o conhecimento e as habilidades necessárias para promover o desenvolvimento rural sustentável. Interações interdisciplinares desempenham um papel crucial na promoção da educação para a sustentabilidade, promovendo a integração de diversos conjuntos de conhecimentos e resultando em uma compreensão mais holística de questões complexas. Essa abordagem não só enriquece a experiência educacional, mas também prepara os alunos para enfrentar os desafios multifacetados da sustentabilidade em suas futuras carreiras. Em última análise, esta pesquisa ressalta o papel crítico da educação em moldar as perspectivas e ações dos futuros profissionais agrários. Através de treinamento direcionado para professores e educação abrangente em sustentabilidade, as instituições podem preparar melhor os alunos para liderar o desenvolvimento rural sustentável, garantindo a resiliência e viabilidade dos sistemas agrícolas para as próximas gerações.

Palavras-Chave: Sustentabilidade, Técnico Agropecuário, Integração Curricular, Percepções dos Alunos, Treinamento de Professores.

1- INTRODUCTION

Historically, agricultural education has focused primarily on technical skills and knowledge related to crop production, animal husbandry, and farm management. However, as the environmental and social impacts of conventional agricultural practices have become increasingly apparent, there has been a growing recognition of the need to incorporate sustainability principles into agrarian education (Conceição & Costa, 2012; Handayani et al., 2020; Osumba et al., 2021). This shift reflects a broader paradigmatic change within the agricultural sector, emphasizing the importance of adopting holistic and environmentally conscious approaches to farming practices.

The urgency of embracing sustainable agriculture is underscored by the interconnected crises that confront humanity today. Climate change, driven primarily by human activities such as deforestation and the burning of fossil fuels (IPCC, 2022), threatens to disrupt weather patterns, degrade soil quality, and exacerbate extreme weather events all of which pose significant risks to agricultural productivity (Yohannes, 2016). Furthermore, the unsustainable use of natural resources (Feng et al., 2023), including water and arable land, places immense strain on ecosystems and compromises their ability to support future food production.

Agriculture is an essential sector in Brazil, which, along with exports, is one of the sectors that most significantly impacts the Gross Domestic Product (GDP), constituting about 20% of the country's economic structure (Sobreira et al., 2018). In the subject of agriculture, the state of Paraná holds significant agricultural importance in Brazil, playing a crucial role in the production of various agricultural products. The stathe of Paraná is one of Brazil's largest grain producers. In 2023, the state produced approximately 36 million tons of soybeans and corn combined, accounting for about 16% of the national production of these grains (IPARDES, 2023).

The state of Paraná also excels in livestock production, especially in pork and poultry. In 2023, the state produced about 2.3 million tons of chicken meat, accounting for approximately 33% of the national production. The state also was responsible for around 1 million tons of pork in 2023, making it one of the top meat producers in Brazil, in which the municipality of Toledo stands out, as the biggest producer of swine in the country (IPARDES, 2023).

Technical Vocational Education and Training (TVET), plays a fundamental role in preparing highly qualified professionals to work in the agricultural sector (Calixte et al., 2020). This type of training is designed to provide students with a comprehensive set of technical skills and specific knowledge related to agriculture and livestock farming. These courses cover a variety of topics, from crop management and animal husbandry to natural resource management and the application of sustainable practices (Moreira, 2009; Santos et al., 2017).

Vocational education plays a categorical role in preparing individuals for the workforce by developing practical skills and specific knowledge necessary for a particular career or industry sector, ensuring that graduates are ready to face the challenges of the professional world. Unlike traditional academic education, which often focuses on theory and general concepts, vocational education is practical and oriented towards applying knowledge in the real work environment. This may include opportunities for hands-on learning, internships, and interactions with experienced professionals in the chosen field (Manfredi, 2016).

In the agriculture fields, students have the opportunity to directly apply what they learn in real environments such as rural properties, laboratories, and experimental fields. This enables them to gain valuable practical experience and develop the skills necessary to tackle the challenges they will face in the real world of agriculture and livestock farming (L. C. A. Barbosa, 2010).

Despite the growing emphasis on the importance of sustainability education in agricultural programs (Oetting, 2022; Panayi, 2018; J. F. L. e Silva & Silva, 2022; Sousa, 2017; Wals & Bawden, 2000), there remains a gap in understanding how these principles are being taught and perceived by students in TVET.

Furthermore, even though there has been some research investigating general population perceptions on sustainability (Almusalami et al., 2024), and students' perceptions (Chaplin & Wyton, 2014; Hay et al., 2019; Machado & Davim, 2023), little is known about how agrarian TVET students perceive sustainable and unsustainable practices in agriculture and society at large, as well as how they define sustainability within the context of their education and future careers.

This article aims to address gaps in the understanding and implementation of sustainability in agrarian technician education by investigating the following key areas: (a) Integration of Sustainability Principles in Curricula; (b) Students' Perceptions of Sustainable and Unsustainable Practices in agriculture, and; (c) Conceptualization and Definition of Sustainability among Students.

This study focuses specifically on TVET students enrolled in the State Agricultural College of Toledo (CAET), located in the municipality of Toledo, state of Paraná. Given that CAET is an agricultural college, the emphasis on sustainable practices is particularly relevant, since sustainable practices in this field are vital for ensuring long-term food security, environmental protection, and economic stability.

The research was conducted using mixed-method approach, with data collected through documentary research, and a comprehensive questionnaire with open-ended, descriptive, and multiple-choice questions, using the Google Forms platform. Understanding how agrarian technician students are being taught sustainability and how they perceive and define sustainability has significant implications for agricultural education, policy, and practice.

By uncovering the strengths and weaknesses of current sustainability education initiatives, this research aims to inform curriculum development, teaching strategies, and broader agricultural sustainability efforts.

Educating future agrarian TVET students about sustainability principles and practices is paramount to ensuring the resilience and viability of agricultural systems. However, the approach to integrating sustainability education into agrarian TVET curricula remains a subject of debate and scrutiny. This article seeks to explore the multifaceted landscape of sustainability education among agrarian technician students, delving into both the core subjects that address sustainability principles and the technical subjects that apply these principles in practical contexts.

The first section explores the relationship between sustainable rural development and education, focusing on the historical context, current challenges, and the role of education in promoting sustainable agricultural practices essential for achieving sustainable rural development. The subsequent section analyzes the curriculum's approach to teaching sustainability, examining how various subjects incorporate sustainability-related topics, including environmental policies, socio-environmental impacts, and sustainable development.

Following that, the analysis emphasizes students' perceptions of how sustainability and related issues are taught at the institution. And finally, suggestions are made to enhance the integration between the curriculum and the practical implementation of sustainable practices in students' daily lives.

2- THEORETICAL FUNDATION

2.1 SUSTAINABLE RURAL DEVELOPMENT AND EDUCATION: THE BEGIN OF THE DEBATE

Understanding how Technical and Vocational Education and Training (TVET) agrarian students are being taught about sustainability, and how they perceive agricultural sustainability, is crucial in shaping the future of sustainable agriculture. This article delves into the current educational approaches within TVET programs, exploring the content and methods used to impart knowledge about sustainability. It also examines the students' perceptions and attitudes towards sustainable agricultural practices. By investigating these aspects, we aim to identify the strengths and gaps in the current curriculum, and to understand how future agrarian professionals are being prepared to address the pressing environmental and socio-economic challenges in agriculture.

We believe that the only path forward to achieve a sustainable future for agriculture lies in embracing sustainable rural development. This approach integrates economic viability, environmental health, and social equity, ensuring that rural communities thrive while preserving their natural resources.

Sustainable rural development focuses on empowering local farmers with knowledge and resources, promoting environmentally friendly practices, and fostering economic opportunities that do not compromise ecological integrity. By prioritizing holistic strategies that address the multifaceted needs of rural areas, we can create resilient agricultural systems that support both current and future generations. This comprehensive approach not only enhances productivity and sustainability but also strengthens the social fabric and economic stability of rural communities (Fayad et al., 2019).

The concept of sustainable rural development involves the harmonious integration of economic, social, and environmental factors in rural communities, aiming to promote the well-being of present and future generations (I. Sachs, 2008). To fully understand this concept, it is essential to explore different dimensions and components that compose it and differentiate it from mere agricultural development.

In this article, we will consider the sustainability perspective of (Sachs, 2009), which involves building resilience and the capacity to adapt to changing environmental and socio-economic conditions. This includes preparing for and mitigating climate change impacts. I. Sachs advocates for a holistic approach, integrating economic, social, and environmental aspects, and argues that development should also focus on social justice and environmental conservation. He stresses the importance of meeting current needs without compromising future generations, emphasizing long-term policy planning. I. Sachs also supports inclusive development processes, ensuring that marginalized communities participate in decision-making, and calls for sustainable strategies tailored to the specific cultural and socio-economic contexts of each region.

For many years, rural development has been associated with the productivity issues, considered synonymous with agricultural (or livestock) development, larger areas, larger machinery, and even larger egos. Thus, in one hand, agricultural development refers to the conditions of agricultural and/or livestock production and its characteristics, with a strictly productive sense: planted area, productivity, technological formats, cost-effectiveness, labor use as a production factor, among many other productive aspects (Graziano da Silva, 1998).

Rural development and sustainable rural development are distinct yet interconnected concepts. Rural development typically focuses on improving the infrastructure, economy, and overall living conditions in rural areas. It aims to enhance access to education, healthcare, transportation, and other essential services, fostering economic growth and raising the standard of living (McAreavey, 2009). In contrast, sustainable rural development extends this concept by incorporating environmental stewardship and social equity into the development process. It emphasizes the need to balance economic growth with the preservation of natural resources and the promotion of social justice. Sustainable rural development seeks to create long-term, resilient communities by ensuring that development practices do not deplete resources or harm

the environment, thereby securing the well-being of future generations alongside current progress (Abramovay, 2012; Salvo et al., 2015).

Thus, sustainable rural development seeks to improve the overall quality of life and meet human needs. Sustainable development, therefore, implies self-confidence and economically viable development, facilitating access to health, shelter, clean water, and food (Mancebo & Sachs, 2015). Sustainable rural development aligns with (Sen, 1982, 1999, 2004, 2010, 2011) conception, in which development is seen as an expansion of real personal freedoms, where only freedom can enhance all human capabilities. Therefore, there will only be development where the individual is free to develop, where there is no injustice, no famine and political freedom.

Sustainable rural development predicates a form of agriculture that prioritizes environmental stewardship, economic viability, and social equity. This type of agriculture, often referred to as sustainable or regenerative agriculture, focuses on practices that maintain and enhance soil health, reduce reliance on chemical inputs, conserve water, and promote biodiversity. It encourages the use of crop rotations, agroforestry, organic farming, and integrated pest management to create resilient agricultural systems (Altieri, 2018).

Sustainable agriculture also seeks to support local economies by promoting small-scale farming and fair-trade practices, ensuring that farmers receive fair compensation for their products. Additionally, it emphasizes the importance of community involvement and knowledge sharing, fostering a collaborative approach to farming that benefits both the environment and rural livelihoods. Through these principles, sustainable rural development aims to create agricultural systems that are productive, environmentally sound, and socially just (I. Sachs, 2008).

According to (Altieri, 2012), sustainable agriculture is defined as a pattern of agricultural production that balances social, economic, and environmental objectives, seeking

to maintain agricultural productivity with minimal environmental impacts and with economic-financial returns adequate to the goal of poverty reduction. In other words, the sustainability of agriculture depends on ecologically safe management practices to ensure sustained long-term productivity.

This multidimensional approach reflects the complexity of rural issues and the need for integrated solutions, highlighting the importance of sustainable agriculture as a central pillar of sustainable rural development (Mancebo & Sachs, 2015a).

Agrarian TVET students are crucial to sustainable rural development and sustainable agriculture because they represent the next generation of farmers, agronomists, and rural entrepreneurs (Bhattacharjee et al., 2007). Equipped with practical skills and contemporary knowledge, these students are poised to implement innovative farming techniques and sustainable practices that are essential for the long-term health of agricultural systems.

In this context, TVET aligns with the direction proposed by P. Freire (2014), where education is seen as an affirmation of freedom, and the struggle for freedom is a challenge of present history. Freire's vision of freedom holds a prominent position in his pedagogy, serving as the foundational matrix that gives meaning to educational practice. This practice can only achieve true effectiveness and efficacy through the free and critical participation of learners.

In this sense, and according to Ramos (2008) vocational education goes beyond simply preparing for the labor market, as it encompasses ethical-political aspects and historical and scientific knowledge that define human activity. Vocational education can contribute to building a fair and integrative society by ensuring the right to basic education and enabling training for professional practice. Additionally, vocational education should integrate fundamental knowledge from basic education so that it does not become just a training course or procedural skill development, but rather a comprehensive vocational education (Ramos, 2008).

According to P. C. B. Silva & Lima (2023), the conception of Integrated High School is based on a unitary and polytechnic education model, with guiding principles of science, culture, technology, and work in its ontological sense. The goal is to seek comprehensive education, addressing all essential dimensions of life. Regarding agricultural education, education can play a crucial role in helping family farmers overcome challenges and barriers, providing them with the knowledge and skills necessary to make informed decisions towards sustainable agriculture (Maini et al., 2021).

In this context, the training of agricultural technicians plays a key role in empowering rural communities to adopt agricultural practices that not only meet present needs but also preserve natural resources for future generations.

Through vocational education and the training of agricultural technicians, we can empower communities to embrace sustainable practices that not only meet present needs but also preserve natural resources for generations to come. By integrating principles of agroecology and regenerative farming into agricultural education and practice, we can build a more prosperous and sustainable world for all.

In the context of Technical and Technological Education (TTE), the Sustainable Development Goals (SDG) can be seen as an opportunity to promote sustainability and transdisciplinarity in professional training. The inclusion of the SDGs in pedagogical debate allows students to awaken and advance their understanding of the future, both in their own profession and for the planet. The proposal is for the SDGs to be incorporated into TTE curricula in a transversal manner so that students can develop transdisciplinary skills and understand the importance of sustainability in their fields of activity (Pereira, 2022).

TVET students play a vital role in this context as they are the agents of change who can empower rural communities to adopt more sustainable approaches to food and natural resource production, sustainable agriculture and consequently the SDGs set by the United Nations (UN),

including eradicating hunger, responsible water usage, promoting gender equality, and conserving biodiversity (UNESCO, 2024).

For P. Freire (2013), education should be a dialogical approach that allows the exchange of knowledge and experiences between educators and learners. The role of the educator is not simply to transmit knowledge but to create an environment of dialogue and critical reflection that allows learners to develop their understanding of the world.

Boff (2017) highlights that sustainability results from education, whether formal or informal, where humans redefine, the concepts related to their relationship with the universe, aiming to maintain the ecosystem in its integrity to meet the needs of present and future generations. In this sense, sustainability might possibly be a vision of solidarity, where the pursuit of development must be associated with environmental preservation, ensuring our common future.

Mancebo & Sachs (2015b) argue that education can play a fundamental role in transitioning to sustainability, providing the skills and knowledge necessary to adopt sustainable practices and raise awareness about the importance of sustainability. (Leff, 2020) addresses environmental education as a fundamental tool for awareness and action regarding environmental issues. He argues that environmental education should be critical and reflective, empowering people to question the social and economic structures that perpetuate the environmental crisis.

The training of agricultural technicians plays a significant role in this context. Authors like Altieri (2004) emphasize that there is a significant gap in trained professionals in some regions, which can be an obstacle to the adoption of agroecological practices. Hence, agricultural education should include the understanding and application of sustainable agricultural practices, which promotes the resilience of agricultural systems and the conservation of natural resources.

3- METHODOLOGY

The State Agricultural College of Toledo (CAET) was selected for this study due to its prominent role in agricultural education in the region of Toledo, Paraná in the south region of Brazil. As a specialized institution focusing on TVET agricultural sciences and technologies, CAET offers a curriculum that integrates both theoretical knowledge and practical skills in agrarian studies.

The college provides an ideal setting for studying sustainability in agriculture due to its emphasis on practical learning experiences and its commitment to environmental stewardship. Additionally, the geographical location of CAET in Toledo, a region known for its agricultural production, provides a relevant context for exploring the relationship between education and sustainable rural development. Studying at CAET allows for insights into how agricultural education can contribute to sustainable practices and rural development in the context of Paraná.

After selecting the target school for our research, the next methodological phase focused on the documentary analysis of the course's guiding documents, through the analysis of the course plan documents. The methodology encompasses both quantitative and qualitative data collection methods to provide a comprehensive understanding of students' perspectives.

The study commences with a detailed analysis of the curriculum followed by agrarian technician students, focusing on core and technical subjects related to sustainability. Course materials, syllabi, and academic resources were reviewed to identify specific topics, themes, and learning objectives related to sustainability education.

According to Ludke & André (1986), documents originate from a specific context and provide crucial information about that context. Documentary research plays an essential role in both understanding the case in question and validating evidence through data and results triangulation.

When examining disciplines that may spark discussions about sustainability, we considered criteria such as the mention of “environmental”, “socioenvironmental”, and “sustainable” adjectives, the relationship with national public policies (including environmental education policy), mentions of urgent issues for students' education, and contemporary issues.

Therefore, it is possible to infer that when discussing the presented topics, the approaches encompass issues related to the environment. Regarding data analysis, it is relevant to highlight that in this study, we applied triangulation, emphasizing the combination of collected data with theory, as suggested by (Yin, 2001). This was done to ensure the validation of facts and phenomena identified during the research.

To conduct this research, we initially chose to analyze literature related to the subject in question, with the aim of improving the structure of the research to be carried out. The study was conducted as a qualitative case study, initially based on bibliographic sources and documents. According to Gil (2002) a case study involves researching a particular example, an analysis of a singular reality. According to Fonseca (2002), this type of study seeks an in-depth understanding of the “how” and “why” of a specific situation, often considered unique in various aspects.

The research proposes a detailed examination of the curriculum (which can be seen as a case study) and the qualitative analysis of students' perceptions and definitions of sustainability. The case study approach allows for an in-depth exploration of a specific context or phenomenon, in this case, sustainability education within the agrarian TVET. By combining qualitative data collection and analysis methods, such as curriculum analysis and thematic analysis of questionnaire responses, the study seeks to generate rich insights and understandings of the complexities surrounding sustainability education in this particular context.

Survey design and procedures.

After completing the documentary research, we developed a comprehensive questionnaire with open-ended, descriptive, and multiple-choice questions, using the Google Forms platform. The main purpose of this form was to obtain a deep understanding of students' perceptions regarding sustainable agriculture and sustainability in general based on the studies of (Aleixo et al., 2021; Hyland et al., 2015; Jones et al., 2024). Through these questions, we sought to capture the perspectives and knowledge of the students on these topics to enrich our analysis and contribute to a more comprehensive view of issues related to sustainable agriculture.

Data collection and sample.

The questionnaire was administered to agrarian technician students using the online survey platform, Google Forms, to facilitate data collection and analysis. Students at CAET received the questionnaire via their institutional emails and completed it during scheduled class sessions. The questionnaire covered all sampled grades of the agricultural technician course. To ensure the quality of responses and clarify any doubts, clear guidelines were provided. Participation was voluntary, and data were collected during the first two weeks of February 2024.

A sample of 242 students was obtained. Of the students surveyed, 132 (54.3%) are male and 106 (43.6%) female, and 5 (2.1%) were gender non-specific. The age of respondents varies between 15 and 17, but the highest response rate was in the 16 range. Most respondents were in the second grade 125 (51.7%) and 116 (48.3%) were graduating seniors (Third grade).

Statistical analysis.

To delve deeper, the Mann-Whitney U test was utilized to explore potential statistical variances in students' views on sustainability. Concurrently, open-ended responses underwent thematic analysis, uncovering recurring themes, patterns, and invaluable insights into students'

sustainability perceptions. Leveraging qualitative analysis techniques like coding and thematic analysis, we meticulously interpreted and synthesized students' narratives and perspectives.

Throughout the study, utmost care was taken to uphold ethical standards. Informed consent was diligently obtained from all participants, with assurances of anonymity, confidentiality, and secure data storage for research purposes.

However, it's important to acknowledge potential limitations. Factors such as sample size and participant demographics may impact the generalizability of our findings. Additionally, self-reporting bias and social desirability bias could influence participants' responses, while the cross-sectional design of the study may constrain our ability to establish causal or temporal relationships between variables.

By employing a rigorous mixed-methods approach, this study aims to provide valuable insights into agrarian technician students' perceptions of sustainability education and practices. The combination of curriculum analysis and questionnaire survey allows for a comprehensive exploration of students' perspectives, contributing to the ongoing discourse on sustainability education and its implications for agricultural training and practice.

4- RESULTS AND DISCUSSION

4.1 TEACHING SUSTAINABILITY THROUGH THE CURRICULUM

The integration of sustainability within the curriculum is a fundamental aspect of contemporary education, aiming to prepare students for the challenges of the 21st century. In Brazil, the Law of Guidelines and Bases of National Education (LDB), Lei nº 9.394/1996, emphasizes the importance of incorporating environmental education into primary and secondary school programs. While the LDB does not explicitly use the term “sustainability,” it

mandates the inclusion of environmental education to address issues related to the conservation of natural resources and sustainable development. This approach not only aligns with the broader educational goals of fostering critical thinking and holistic learning but also ensures that students are equipped with the knowledge and skills needed to contribute to a sustainable future. Through interdisciplinary teaching and flexible curricular structures, the LDB promotes an educational framework that is responsive to the environmental and social imperatives of our time (LEI No 9.394, DE 20 DE DEZEMBRO DE 1996, 1996).

Furthermore, the LDB promotes interdisciplinarity by allowing flexible curricular structures that facilitate the integration of various knowledge areas, thereby fostering a holistic and contextualized learning experience. This approach aligns with the broader principles outlined in the LDB, such as ensuring quality education, fostering critical thinking, and preparing students to engage with complex societal challenges. By embedding these concepts into the educational framework, the LDB aims to cultivate informed and responsible citizens capable of contributing to a sustainable future (LEI No 9.394, DE 20 DE DEZEMBRO DE 1996, 1996).

The course curriculum seems to align to the LDB, since it addresses sustainability in various ways, including the analysis of the socio-environmental impacts of government, corporate, and individual practices, the promotion of responsible consumption, discussions on environmental policies, analysis of economic models in the use of natural resources and the promotion of sustainability, among other aspects. Additionally, topics such as sustainable development, greenhouse effect, global warming, environmental conventions and treaties, the role of Non-Governmental Organizations (NGOs) in environmental protection, environmental policies for sustainability, among others, are discussed.

While core subjects may provide theoretical foundations in sustainability, it is essential to examine how these concepts are translated and applied within technical subjects that directly influence on-the-ground agricultural practices (C. L. A. Barbosa, 2010). These approaches aim

to raise students' awareness of the importance of environmental and social sustainability, encouraging reflection and actions that contribute to environmental preservation and sustainable development.

These topics demonstrate the curriculum's concern with addressing environmental issues and promoting students' awareness of the importance of environmental preservation and the adoption of sustainable practices. The terms “environmental,” “socio-environmental,” and “sustainable” appear in various disciplines and contexts throughout the course curriculum in the following subjects (table 01).

Table 1- Analysis of sustainability related topics on core subjects.

Discipline	Use of the terms “environmental,” “socio-environmental”
Geography	These terms are frequently used when discussing environmental policies, socio-environmental impacts, sustainable development, and nature conservation, among other aspects related to the interaction between society and the environment.
Biology	The terms are employed when addressing topics such as biogeochemical cycles, ecological relationships, biodiversity, and environmental conservation, among others.
Chemistry	They can be found when discussing environmental pollution, the impacts of chemical substances on the environment, and the development of sustainable technologies, among others.
History	The terms are mentioned when analyzing socio-environmental transformations over time, and the impacts of historical events on the environment, among others.
Sociology	They are used when discussing issues of socio-environmental inequality, social movements advocating for the environment, and sustainable public policies, among others.
Agroecology and environmental management	The subject aims to foster critical thinking on environmental issues and promote practices in agroecology and sustainable development. Understand methods to enhance soil fertility in agroecological systems. Acknowledge the role of plants in agroecological practices. Plan the transition to agroecology and offer recommendations for certification. Manage waste effectively to prevent environmental harm.
Agricultural Practice	The discipline aims to manage animal and plant species for rural property management. Execute routine tasks on rural properties. Analyze data from research sources. Propose viable

	solutions to professional challenges. Apply theoretical knowledge practically. Develop research projects and publish scientific papers. Establish experimental areas for sharing technological knowledge. Consult relevant legislation and regulations. Apply Agribusiness theory to practice. Identify professional challenges and research sources. Design research tools. Create detailed research samples. Conduct field research. Document project stages. Organize research data effectively.
Agriculture	The subject aims to help students recognize and mitigate the environmental impacts of fertilizers and correctives. Optimize climatic factors through planning and monitoring. Develop cultivation schedules and cultural treatment plans. Implement harvesting, storage, and processing techniques. Identify plants with high solar energy utilization. Calculate seed requirements and planting parameters. Evaluate cultural value. Select and prepare seeds. Conduct sowing and planting operations. Determine optimal harvesting timing. Oversee harvesting, storage, and processing using efficient methods.
Soil Management and Conservation	The discipline aims to present soil as a living, dynamic organism with intricate interrelations. Explore soil origins and distinctions among soil types, recognizing their compositions and agricultural implications. Deepen understanding of soil interactions and their significance in fertility. Recognize signs of nutrient imbalances in soil fertility. Comprehend the soil-plant relationship and nutrient exchanges between them. Engage in soil dynamics to sustain or restore fertility through sustainable practices and prudent management.

Source: The authors, based on (CAET, 2018).

These terms are frequently encountered across various core disciplines, underscoring the significance of integrating environmental, socio-environmental, and sustainable perspectives into diverse areas of knowledge and students' education. Consequently, these findings underscore the critical importance and urgency of adopting a multidisciplinary and interdisciplinary approach to teaching, as already pointed out by Knobloch et al. (2019), Wang et al. (2020), Gulnoza (2021) e Coutinho et al. (2023)

The curriculum extensively addresses sustainability across various core disciplines, including Geography, Biology, Chemistry, History, and Sociology. This interdisciplinary approach underscores the significance of incorporating environmental, socio-environmental,

and sustainable perspectives into diverse areas of knowledge. Moreover, the inclusion of topics such as environmental policies, ecological relationships, conservation, and socio-environmental impacts reflects a comprehensive approach to fostering environmental awareness and promoting sustainable development among students.

The prominence of terms like “environmental,” “socio-environmental,” and “sustainable” across different subjects underscores the curriculum's commitment to addressing environmental issues and promoting sustainability. These terms are recurrent throughout various core disciplines, emphasizing the importance of integrating sustainability principles into students' education.

Regarding the Sustainable Development Goals (SDGs), the course curriculum does not explicitly mention them by name. However, the topics and themes discussed in the course plan, such as sustainable agriculture, environmental conservation, social responsibility, and economic viability, are closely aligned with the objectives of the Sustainable Development Goals set by the United Nations. These disciplines collectively contribute to the promotion of sustainable agriculture practices, environmental conservation, and the long-term viability of agricultural systems while considering social, economic, and environmental dimensions.

When discussing the importance of addressing sustainability in schools, and how this theme can contribute to the school curriculum and the civic education of individuals, Espínula et al. (2012) points out that sustainability plays a fundamental role in the civic education of students by raising awareness about the importance of caring for the environment, society, and future generations. By integrating sustainability into the school curriculum, students are encouraged to develop skills and attitudes that make them responsible citizens committed to preserving the planet.

In their article, Espínula et al. (2012) also point out that education for sustainability goes beyond theoretical knowledge about environmental issues; it also involves practicing

sustainable actions in daily life, such as reducing the consumption of natural resources, recycling waste, and using water and energy consciously, among other practices. In this way, students are empowered to make ethical and sustainable decisions in their personal and professional lives, contributing to the building of a more balanced and conscious society.

Therefore, sustainability in the civic education of students not only prepares individuals to face current environmental, social, and economic challenges but also empowers them to act proactively in the pursuit of sustainable solutions and the promotion of more equitable and lasting development. More than workforce training, the course, in accordance with the National Curriculum Guidelines, is concerned with the critical-citizen education of individuals; thinking beings who need to understand the productive process in a global manner and mobilize technological values for correct decision-making.

L. C. A. Barbosa (2010) discussing the importance of environmental education in the training of agricultural technicians, stresses that the agriculture should engage with broader principles within the spectrum of sustainability concepts by undertaking initiatives that go beyond the merely corporate horizon. Additionally, when asking teacher to ponder about sustainability related issues, the author concludes that the interviewed teachers did not agree with the statement that the planet is self-regulating.

In conclusion, the emphasis on sustainability within the curriculum, as guided by the principles of the Law of Guidelines and Bases of National Education (LDB), represents a crucial step towards fostering an environmentally conscious and socially responsible generation. By integrating environmental education across various subjects and promoting interdisciplinary approaches, the curriculum not only addresses the urgent need for conservation and sustainable development but also cultivates critical thinking and informed citizenship among students. These educational efforts mark a significant improvement from past approaches, ensuring that students are better prepared to navigate and address the complex

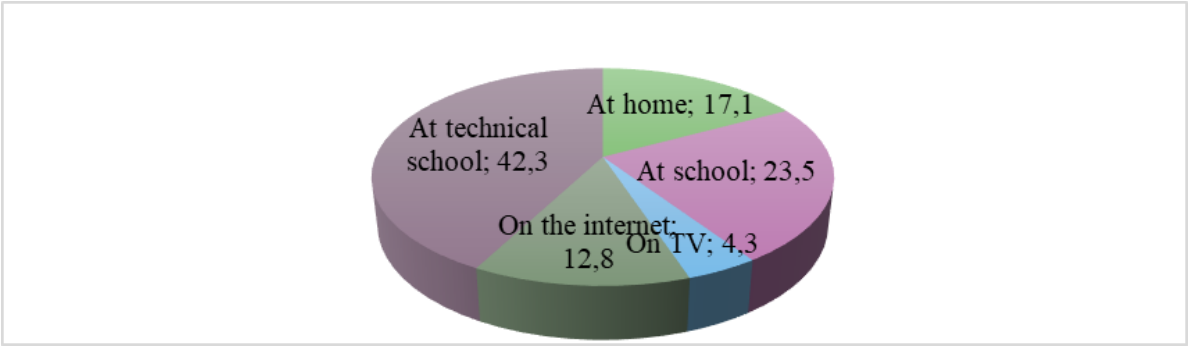
environmental and socio-economic challenges of the future. As the curriculum continues to evolve, its commitment to sustainability will remain a cornerstone in shaping the minds and values of young learners, empowering them to make meaningful contributions to society and the planet.

4.2 TEACHING SUSTAINABILITY THROUGH THE CURRICULUM ACCORDING TO STUDENTS

This section began with a direct question: “Do you know what sustainability is?” Students were given only two response options: yes or no. When asked if they know what sustainability is, 90% of the students answered “yes”, indicating that the majority of students have some level of awareness or understanding of the concept. Conversely, 10% of the students answered “no” suggesting that there is a minority of students who may not even be familiar with the concept of sustainability.

The subsequent question aims to evaluate students' familiarity with the term “sustainability”. To assess this, students were queried about where they initially encountered the term “sustainability” (Figure 01).

Figure 1 – First contact with the sustainability matter.



Source: The authors (2024).

The results indicate that a significant portion of students first encountered the term “sustainability” at technical school, with 42.3% reporting this as their initial exposure. Following this, 23.5% of students mentioned encountering the term at school itself. A smaller percentage of students, 17.1%, stated that they first heard about sustainability at home. Additionally, 12.8% reported encountering the term on the internet, while only 4.3% mentioned hearing it from television sources. These findings highlight the varied sources through which students are introduced to the concept of sustainability, with technical school playing a prominent role in their awareness.

The data supports the well disseminated ideas of several authors, such as (Hermawan et al., 2022; Igbokwe, 2012; McKeown & Rosalyn, 2006) embracing and elucidating concepts of sustainability within high school education is crucial for several reasons. Firstly, it equips students with the knowledge and skills necessary to understand the complex interconnections between environmental, social, and economic systems. This understanding is vital in preparing them to address pressing global challenges such as climate change, resource depletion, and social inequality. By integrating sustainability into the curriculum, schools foster critical thinking and problem-solving abilities among students, empowering them to become informed and responsible citizens capable of making positive contributions to society. Moreover, teaching sustainability promotes a sense of environmental stewardship and encourages students to adopt more sustainable behaviors in their daily lives, leading to tangible benefits for both present and future generations. Additionally, incorporating sustainability into education helps students develop a deep appreciation for the natural world and a sense of connection to their local and global communities.

Overall, by embracing and elucidating concepts of sustainability, schools not only prepare students for the challenges of the 21st century but also inspire them to become agents

of positive change in their communities and beyond (McKeown & Rosalyn, 2006). When evaluating sustainability itself, it is important to notice that sustainability can be seen as both a concept and a philosophy, depending on how it's approached and understood. As a concept, sustainability refers to the idea of meeting the needs of the present without compromising the ability of future generations to meet their own needs. It's a practical framework for thinking about how to manage resources and systems in a way that ensures their long-term viability (Boff, 2017).

Sustainability can also be viewed as a philosophy, a guiding principle or set of values that underpins actions and decisions. It involves adopting a mindset that prioritizes the well-being of the planet, future generations, and the broader interconnectedness of all living things (Bursztyn et al., 2023). So, while sustainability is rooted in a concrete idea or concept, it also encompasses broader philosophical principles that shape how individuals, organizations, and societies approach issues related to environmental stewardship, social equity, and economic prosperity.

Subsequently, students were prompted to elaborate on the concept and provide their own definition of sustainability in an open-ended question format. Following data collection, the responses were evaluated and ranked based on their level of satisfaction, ranging from 0 to 4. The obtained data was presented in the table below (Table 2).

Table 2- Analysis of sustainability knowledge.

Score	Description	n	%
0	Non-Satisfactory Answer	51	21
1	Barely Answered	80	33
2	Barely Satisfactory Answer	36	15
3	Almost Satisfactory Answer	34	14
4	Satisfactory Answer	43	18

Source: The authors (2024)

The largest proportion of responses falls within the category of “Non-Satisfactory Answer” (0), comprising approximately 21% of the total responses. This indicates that a significant portion of students provided answers that did not meet the satisfactory criteria for understanding sustainability concepts.

The next most common category is “Barely Answered” (1), representing approximately 33% of the responses. This suggests that a considerable number of students provided minimal or incomplete responses to questions about sustainability. Some of the answers in this category included:

> “I don't know how to define it properly.” (Student 3, 2024).
>
> “For example, when a farm manages to sustain itself with its own products, such as pig manure.” (Student 154, 2024)
>
> “Using something without affecting future beings.” (Student 20, 2024)
>
> “Producing without harming other chains.” (Student 125, 2024).

The category of “Barely Satisfactory Answer” (2) accounts for approximately 15% of the responses, indicating that a smaller proportion of students provided answers that were somewhat satisfactory but still lacked depth or clarity. The category of “Barely Satisfactory Answer” (2) accounts for approximately 15% of the responses, indicating that a smaller proportion of students provided answers that were somewhat satisfactory but still lacked depth or clarity.

“Almost Satisfactory Answer” (3) and “Satisfactory Answer” (4) categories represent approximately 14% and 18% of the responses, respectively. This suggests that fewer students demonstrated a more comprehensive understanding of sustainability, with a minority providing answers that were nearly or fully satisfactory. Some of the answers in this category included:

> “Sustainability is the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs. This involves seeking a balance between economic, social, and environmental aspects, ensuring that human activities do not exceed natural limits and do not harm the well-being of future generations.” (Student 30, 2024).
>
> “Capacity for conscientious use of natural resources without compromising the well-being of future generations.” (Student 25, 2024).
>
> “Practices that will help maintain food and a climate favorable to agriculture and general life.” (Student 212, 2024).
>
> “Ability to conscientiously use natural resources without compromising the well-being of future generations.” (Student 197, 2024).
>
> “Being sustainable and preserving in some way through practices, making the activity you're going to undertake not cause harm to the environment, also seeking to respect the soil and its nutrients in agriculture.” (Student 184, 2024).

The data indicates that a significant proportion of students provided answers categorized as “Non-Satisfactory” or “Barely Answered” when asked about sustainability concepts. However, it's interesting to note that despite this, a high percentage of students (90%) claimed to know what sustainability is. This apparent contradiction suggests that while students may be familiar with the term “sustainability” on a surface level, their understanding of its underlying concepts may be limited.

The discrepancy between students' self-reported familiarity with sustainability and their actual knowledge, as reflected in their responses to specific questions, highlights the importance of distinguishing between awareness and comprehension. While many students may recognize the term “sustainability”, they may struggle to articulate its principles or apply them in context, resulting in non-satisfactory or barely satisfactory answers.

This contradiction underscores the need for targeted educational interventions aimed at deepening students' understanding of sustainability concepts. Simply being aware of the term

is not sufficient; students must develop a nuanced understanding of sustainability and its implications for various contexts, including agriculture, economics, and social equity. This may require implementing comprehensive sustainability education programs that go beyond surface-level awareness to promote critical thinking, problem-solving skills, and practical application of sustainability principles.

Furthermore, the data suggests that there is a subset of students who do demonstrate a more comprehensive understanding of sustainability, as evidenced by their responses categorized as “Almost Satisfactory” or “Satisfactory”. These students may serve as valuable resources in peer-to-peer learning initiatives or as examples of the level of understanding that can be achieved through effective sustainability education.

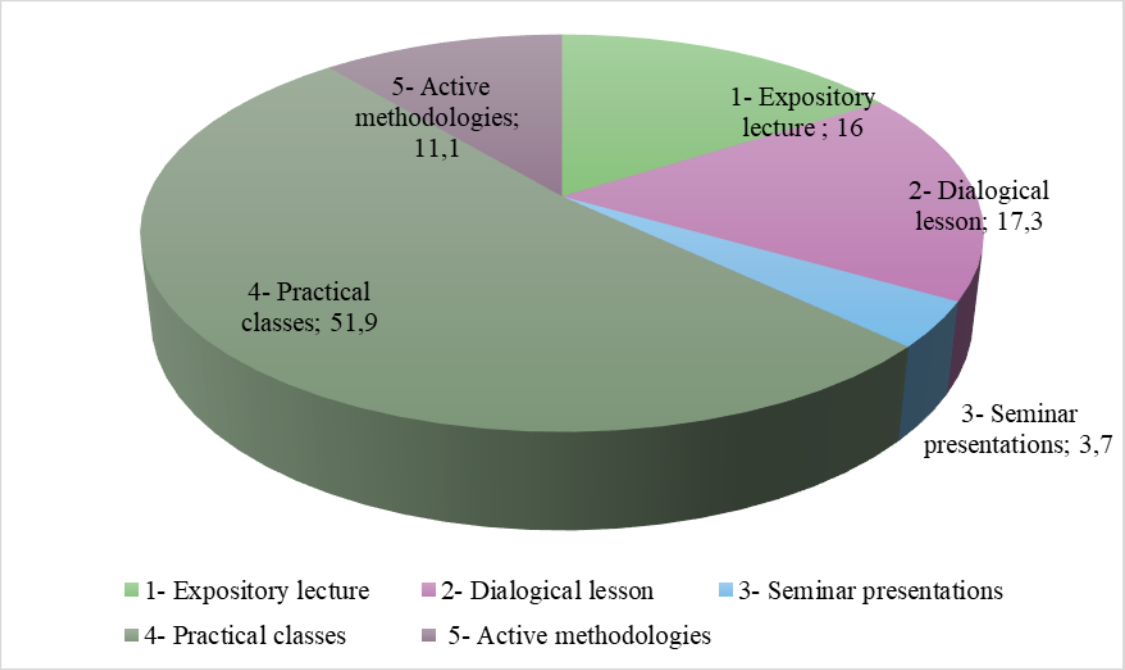
While the majority of students may claim familiarity with sustainability, there is a clear need for targeted efforts to improve their understanding and application of sustainability concepts. By addressing gaps in knowledge and promoting deeper comprehension, educational institutions can better prepare students to address the complex challenges of sustainability in their future endeavors.

The Mann-Whitney U test of how each grade performed in this question revealed a noteworthy pattern, with a p-value of 0.02361, which is less than the commonly used significance level of 0.05. This indicates a statistically significant difference between the scores of the two groups of students, second and third grade. This improvement in scores could be attributed to various factors, such as different teaching methods, materials, or other influences on each group's performance. However, it is fascinating to see that as students advance in their subjects, their scores also advanced.

In the sequence, students were asked which types of classes they found most helpful in understanding the concepts and implications of sustainability. The data (Figure 2), suggests that practical classes are perceived as the most effective in facilitating the study of sustainability,

with 51.9% of respondents favoring this class style. Practical classes likely offer hands-on experiences, allowing students to directly engage with sustainability concepts and apply them in real-world contexts. This active engagement can deepen understanding and retention of the material.

Figure 2 – The best way to learn about sustainability.



Source: The authors (2024).

These results go in the direction intended by (Freire, 2014), the author emphasized in many of his books the importance of practice as one of the fundamental requirements of his pedagogy. He believed that theory should be closely linked to practice, acknowledging the privileges of the latter. He sought coherence between theoretical principles and the practical action of the educator, emphasizing the need to utilize all existing institutional possibilities for mobilization and transformation. Thus, Freire (2014) valued the integration of theory and

practice, highlighting the importance of an education that not only transmitted knowledge but also stimulated action and social transformation.

The data is consistent with (Gonzaga & Arruda, 2016; Leite et al., 2005; Peruzzi & Fofonka, 2021), they indicate that young adult students not only enjoy this type of class but also feel motivated by it, particularly when conducted in a laboratory setting. Therefore, the development of such classes emerges as a valuable tool in science education for young adults.

Nonetheless, some authors, like (Abrahams & Millar, 2008), argue that there seems to be an exaggerated emphasis by teachers on the significance of practical activities in promoting effective learning. However, some argue that merely engaging students in practical tasks in a lab does not always result in them being able to connect theoretical knowledge with practical application.

This may be the case in this research. The CAET curriculum primarily emphasizes practical classes, to the extent that disciplines like agricultural practice do not allocate specific time for theoretical content. In contrast, other disciplines, such as soils, incorporate one theoretical class for every two practical classes. A better balance between theoretical and practical classes could offer students a more comprehensive understanding of why a specific practice is deemed sustainable or not. This balance would empower them to become more independent in the decision-making process within their future roles as technicians.

Following practical classes, dialogical lessons are also favored, with 17.3% of respondents indicating their effectiveness. Dialogical lessons involve interactive discussions and exchanges between the teacher and students, fostering critical thinking and collaborative learning. This style may encourage students to explore diverse perspectives on sustainability issues, enhancing their comprehension and analytical skills.

Expository lectures, although traditional, are still valued by some respondents, with 16% indicating their preference. While expository lectures may provide a structured overview of

sustainability concepts, they may not always encourage active participation or deeper engagement compared to other class styles.

Seminar presentations and active methodologies are less favored, with 3.7% and 11.1% of respondents respectively. Seminar presentations may offer opportunities for students to research and present sustainability topics, but they may not provide the same level of hands-on experience as practical classes. Active methodologies, while engaging, may not be as widely used or preferred in the context of sustainability education compared to more traditional approaches.

To create an environment of dialogue and critical reflection in education, it is necessary for the educator to problematize reality with their students, that is, to question and challenge their assumptions and beliefs about the world. This can be done through open-ended questions that encourage students to think critically about their experiences and consider different perspectives (Freire, 2018; Freire, 2013).

Another important technique is horizontal dialogue, where the educator and learners are seen as equal partners in the learning process, rather than a vertical relationship where the educator is seen as the holder of knowledge (Knowles & Holton, 2011; Ribeiro et al., 2020). Additionally, the author argues that education should be relevant to students' reality, considering their needs and desires, and should be a critical approach that allows for the analysis of social and political structures that shape their lives (Freire, 2013).

In the subsequent and concluding section, in an open-ended question, students were prompted to identify among all their classes, which ones ignited conversations and advancements in sustainable agricultural practices, environmental awareness, and sustainable development. The data is presented below (Table 3).

Table 3 – The classes that students learned the most about sustainability.

Discipline	n
Agriculture	60
Agroecology	27
Horticulture	10
Soils	9
Environmental Management	9
Agriculture and Livestock Farming	7
Rural Infrastructure	5
Applied Agriculture and Zootechnics	5
Soil Practices	4
Animal Agroindustry	4
Practical Classes	3
Introduction to Agriculture	2
Animal Husbandry Practice	2
Agricultural Practice	2
Administration	2
Precision Agronomy	1
Portuguese	1
Planting Tree	1
Plant Agroindustry	1
Mathematics	1
Infrastructure	1
Geography	1
General Practices	1
Financial Education	1
Agricultural Classes	1
Agribusiness	1

Source: The authors (2024).

The data provided showcases the distribution of responses regarding which disciplines sparked conversations and advancements in sustainable agricultural practices, environmental awareness, and sustainable development. Agriculture emerged as the most frequently mentioned discipline, with 60 responses. This indicates a strong association between the field of agriculture and discussions surrounding sustainability. Agroecology followed closely behind with 27 responses, highlighting its significance in promoting sustainable agricultural practices and environmental consciousness.

Other disciplines such as Horticulture (10 responses), Environmental Management (9 responses), and Soils (9 responses) also garnered notable mentions, underscoring their roles in addressing sustainability challenges within the agricultural sector. Agriculture, Agroecology and Environmental Management, and Soils are disciplines that are both emphasized in the curriculum and frequently mentioned by students as discussing sustainability-related topics. This alignment indicates a successful integration of sustainability principles into these subjects as intended by the curriculum.

However, in disciplines like Horticulture, there is a contrast between the curriculum's lack of prediction regarding sustainability topics and students' perceptions, indicating a potential gap between the intended curriculum and the actual implementation of sustainability education. Horticulture is a discipline that is not explicitly predicted in the curriculum to discuss sustainability-related topics. However, students perceive the subject as contributing to the sustainability conversation. This suggests that while the curriculum may not explicitly outline connections to sustainability, the teaching approach employed by the teacher responsible for Horticulture aligns with sustainability principles.

It is noteworthy that some disciplines received fewer mentions, such as Agronomy, Infrastructure, and Mathematics, each with only one response. While these disciplines may not be as directly associated with sustainability, they still play important roles in providing foundational knowledge and support for sustainable agricultural practices. The comparison between the course curriculum's emphasis on sustainability-related topics across various core disciplines and the students' perception of which subjects discuss these topics most frequently reveals an interesting contrast.

Enhanced interaction between disciplines not only fosters the integration of diverse knowledge sets, resulting in a more holistic understanding of intricate issues, but also profoundly influences the alignment of learning outcomes, teaching methods, and assessment

strategies across disciplines. This constructive alignment ensures their mutual support and coherence, thereby enabling a more effective educational experience (Klaassen, 2018).

Moreover, interdisciplinary interactions play a crucial role in defining problems from multiple perspectives, enabling a nuanced and comprehensive approach to problem-solving. By bringing together diverse ideas, perspectives, and methodologies, heightened interdisciplinary interaction can ignite innovation and creativity (Gardiner, 2020; Richard et al., 2021)

This amalgamation of viewpoints not only enhances the relevance of education by addressing intricate, real-world problems but also cultivates essential skills like communication, teamwork, and adaptability, indispensable for succeeding in diverse professional environments. Thus, fostering collaboration across disciplines not only enriches the educational experience but also prepares students for the challenges of the modern world (Matte et al., 2021; Santos et al., 2020).

Schneider (2012) discussing the importance of interdisciplinarity in the curriculum, emphasizing its role in promoting sustainable development in rural areas. Interdisciplinarity is crucial for addressing the complex environmental, economic, and social issues in rural contexts, fostering a holistic approach to sustainable development. Ethical principles such as autonomy, responsibility, solidarity, and respect for the common good guide the school's actions towards sustainable rural development. The educational approach at the school involves active participation of students, families, and educators in interdisciplinary activities, contributing not only to academic learning but also to the economic, social, and cultural development of the community. Overall, interdisciplinarity plays a pivotal role in enhancing understanding of sustainable development and in fostering a collaborative and integrated educational approach in rural settings.

The comparison between the course curriculum's emphasis on sustainability-related topics across various core disciplines and the students' perception of which subjects discuss

these topics most frequently reveals an interesting contrast. In the course curriculum, there is a clear intention to integrate sustainability, environmental, and socio-environmental activities into various core disciplines. This is evident from the extensive list of topics related to sustainability addressed in subjects such as Geography, Biology, Chemistry, History, and Sociology. The curriculum aims to provide students with a comprehensive understanding of environmental issues and their implications across different domains of knowledge. Consequently, the curriculum's design reflects a holistic approach to sustainability education, emphasizing the interconnectedness of environmental, social, and economic dimensions.

However, the students' perception of which subjects most often discuss sustainability-related topics differs from the curriculum's intentions. According to the students' rankings, only three core subjects, Mathematics, Portuguese and Geography are mentioned as frequently discussing these topics. This stark contrast suggests a potential discrepancy between the curriculum's objectives and students' perceptions of sustainability education within the course.

One possible explanation for this gap could be the students' subjective interpretation of which subjects emphasize sustainability-related topics the most. It is possible that students may perceive these subjects as discussing sustainability more frequently due to specific contexts or examples used in daily problems or applications. Alternatively, students may have different expectations or interpretations of what constitutes a discussion on sustainability, leading to variations in their perceptions across different subjects.

Furthermore, this contrast highlights the importance of student feedback and perceptions in curriculum development and evaluation. While the curriculum may intend to integrate sustainability topics across various disciplines, students' perceptions provide valuable insights into the effectiveness of these efforts and areas for improvement. Incorporating student feedback and perspectives can help ensure that sustainability education is meaningful, relevant, and impactful for students.

This lack of feedback could be addressed through periodic institutional assessments. Institutional assessment plays a pivotal role in fostering the autonomy of the school through various means. It offers valuable support for enhancing the quality of educational endeavors, empowering the school to pinpoint challenges and make well-informed decisions regarding its trajectory. Moreover, institutional assessment serves as an ongoing forum for discussing the practices within the school, an intrinsic element in nurturing autonomy, as it fosters a comprehensive understanding of both the institution and the broader educational system (Almeida & Silva, 2017).

Through reflection on its educational objectives and the development of its political-pedagogical project, the school consciously exercises its pedagogical autonomy, basing decisions on insights gleaned from the educational process. This autonomy is manifested through collaborative initiatives aimed at addressing prevailing issues, thereby directly impacting the caliber of education provided to students (Almeida & Silva, 2017).

Consequently, institutional assessment not only aids in identifying areas for improvement but also strengthens the school's capacity to make autonomous and well-informed decisions. This contributes to the establishment of more effective management practices that are attuned to the needs of the school community. Additionally, it could help assess the effectiveness of the teaching methodology in engaging and captivating students.

In a more alarming scenario, if the disparity between the curriculum's emphasis on sustainability-related topics and students' perceptions of these discussions in core disciplines stems from inadequate integration by teachers, investing in targeted education and training for educators could emerge as a viable solution.

By providing professional development opportunities focused on sustainability education, teachers can gain the knowledge, skills, and resources necessary to effectively incorporate sustainability-related topics into their lesson plans and classroom activities. This

training could include workshops, seminars, and courses specifically designed to help teachers understand the principles of sustainability, identify relevant connections within their respective disciplines, and develop instructional strategies that engage students in meaningful discussions and activities related to sustainability (Borsari & Vidrine, 2005; Hay et al., 2019; Kleespies & Dierkes, 2022; Machado & Davim, 2023).

In the same line, (Diao & Hu, 2022) analyzing the scales for TVET teachers' teaching competency in the information age highlights the significance of sustainable development in the context of preparing TVET teachers. It emphasizes the need for high-quality education to provide high-quality teacher resources, especially in the digital age where information technology plays a crucial role in breaking the limitations of learning time and space.

The findings also align with (Pereira, 2022), who analyzed sustainability practices to achieve transdisciplinarity in Vocational and Technological Education (VTE). In light of changes in the job market and environmental issues, Pereira concludes that VTE faces challenges such as the need for constant updating due to rapid technological evolution. This requires continuous revision of curricula and teaching methodologies to ensure the training of professionals aligned with market demands. Additionally, it necessitates the integration of sustainability at all levels of VTE, from curricula to institutional practices, while overcoming resistance and promoting a paradigm shift. There is also a need to invest in the continuous training of teachers, so they are prepared to address complex topics such as sustainability in an interdisciplinary and transdisciplinary manner.

Chewachong, (2021) discussing teacher quality and the quality of technical and vocational education and training (TVET) courses for sustainable development reveals that the major challenges in the supply and quality of TVET teachers in Cameroon are teacher shortages, recruitment and retention issues, disparities in teacher distribution, low salaries and social status, and inadequate funding and infrastructure. The recommendations include enhancing

teacher training programs, providing incentives and better salaries to attract and retain qualified educators, fostering collaboration between stakeholders and industry to align curricula with labor market needs, and implementing policy reforms that prioritize TVET education with adequate funding and address recruitment and retention challenges.

Furthermore, targeted education and training can empower teachers to explore interdisciplinary approaches to teaching sustainability, fostering collaboration across different subject areas, and promoting holistic learning experiences for students. Teachers can learn how to integrate sustainability themes into existing curriculum frameworks, adapt teaching materials to incorporate real-world examples and case studies, and facilitate student-led inquiries and projects that explore sustainability challenges and solutions (Agbaje et al., 2001).

Investing in teacher education and training can also help build a community of practice among educators committed to sustainability education. Teachers can share best practices, exchange resources and ideas, and collaborate on curriculum development initiatives aimed at enhancing sustainability education across the school.

According to (Ramos Moreira & Marques, 2020) Sustainability in the Integrated High School Program at IFMT is understood and intended to be practiced through different educational approaches and practices. (Ramos Moreira & Marques, 2020) highlight that sustainability on IFMT context aims to promote the holistic development of students, fostering intellectual autonomy, critical thinking, and creative spirit. Additionally, there is a focus on reflecting on the impact of the introduction of new technologies in productive processes and the environment, with the goal of training professionals capable of guiding project development based on a critical analysis of the elements that influence productive processes with the introduction of innovative technologies. Students are encouraged to be aware of their role in the continuous improvement of organizations, adopting a proactive, creative, and reflective

stance, and developing a sense of responsibility and commitment to ethical principles, sustainability, and social development, as well as a commitment to the quality of their work.

These educational practices reflect a concern for training professionals who are not only technically skilled but also socially and environmentally responsible, prepared to operate in a constantly changing market with different technological levels and scales of production. The approach to sustainability in the Integrated High School Program at IFTM thus seeks to integrate theoretical and practical knowledge, promoting a holistic and critical view of contemporary environmental and social challenges, and in accordance with what was found at CAET. However, as was found in CAET, it is also noted that there is a lack of holistic education and the issue of sustainability, despite these topics being among the course objectives.

5- CONCLUSIONS

The data from this study can significantly aid both academia and society by providing critical insights into the current state of sustainability education within agrarian Technical Vocational Education and Training (TVET) programs. For the academic community, this research highlights the gaps and strengths in integrating sustainability principles into the curriculum, which can inform future curriculum development and pedagogical strategies. This can enhance the preparation of future professionals in the agricultural sector, ensuring they are equipped with the necessary knowledge and skills to promote sustainable practices. For society, the study underscores the importance of sustainability education in shaping environmentally conscious and socially responsible individuals who can contribute to sustainable rural development. By addressing these educational gaps, the findings can support policy makers and educational institutions in their efforts to foster a more sustainable agricultural sector.

The study reveals that while the curriculum of the Agricultural Technician course at the State Agricultural College of Toledo (CAET) demonstrates a strong commitment to sustainability education, there are notable gaps in its implementation. The curriculum is designed to empower students with the knowledge, skills, and awareness necessary for promoting environmental preservation and sustainable development within the agricultural sector. However, the research highlights discrepancies between the intended curriculum and its practical application, suggesting that the current teaching methods may not fully capture the potential of sustainability education. This gap results in students not achieving optimal performance in sustainability-related topics both in agriculture and in their daily lives.

To address these challenges, the study emphasizes the need for a multidisciplinary and interdisciplinary approach to teaching sustainability. Such an approach would better equip students with the essential tools to tackle complex sustainability challenges and advocate for the long-term viability of agricultural systems. The findings indicate that practical, hands-on classes are perceived as the most effective for studying sustainability, followed by dialogical lessons, highlighting the importance of active engagement and experiential learning.

The study also underscores the value of integrating sustainability themes across all disciplines through targeted teacher education and training. By fostering a community of practice among educators, sharing best practices, and developing collaborative curriculum initiatives, the agricultural technician course can more effectively prepare students to serve as proactive agents of change in advancing sustainability within the agricultural sector and beyond. TVET not only serves to train professionals and provide quality in the technological modernization processes but also seeks to train professionals who know how to do, know why to do it in that way, and least but not last, know how to be, which can only be achieved if there is a commitment from those involved in the educational process, especially the teachers.

Finally, targeted education and training for teachers can play a crucial role in bridging the gap between the curriculum's intentions and students' perceptions of sustainability education. By equipping teachers with the necessary knowledge, skills, and support, schools can ensure that sustainability becomes an integral part of the teaching and learning experience, preparing students to address complex environmental and societal challenges in the future. The limitations of this study include its focus on a single institution, the State Agricultural College of Toledo (CAET) in Paraná, Brazil, which may limit the generalizability of the findings to other regions or educational settings.

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ARTICLE 02- BRIDGING PERSPECTIVES: A COMPARATIVE STUDY OF THE PERSPECTIVES OF SUSTAINABLE DEVELOPMENT GOALS AMONG ADVANCED AND TECHNICAL STUDENTS

ABSTRACT

This study investigates the perspectives of students in agricultural and rural education on the Sustainable Development Goals (SDGs) by comparing two distinct cohorts: high school agricultural vocational education students and advanced students in master's and doctoral programs in sustainable development. Using structured questionnaires administered via Google Forms, the research examines the awareness, understanding, and perceived importance of each SDG among these students. Data analysis, employing descriptive statistics, Welch's t-test, and inferential tests, reveals significant disparities in perceptions between the two groups. Advanced students generally exhibit a stronger understanding and assign higher importance to the SDGs compared to their agricultural counterparts, who demonstrate more conservative viewpoints. Both cohorts, however, emphasize specific SDGs related to agriculture and clean energy, particularly in terrestrial environments. The findings underscore the critical role of integrating environmental education into curricula to enhance awareness, empower students, and promote sustainable practices. Emphasizing consumerism and sustainable behaviors can deepen students' understanding of the need for sustainable consumption, especially concerning nonrenewable resources like fossil fuels and chemical fertilizers. The study also highlights the need for holistic approaches to sustainability education that encompasses environmental, social, and economic dimensions, preparing students to contribute actively to sustainable development. Notable gaps in knowledge, especially regarding the social and economic aspects of sustainability, suggest the necessity for tailored educational approaches. Addressing these gaps is essential for developing inclusive and effective sustainable development education programs,

ensuring future educators can foster environmental stewardship and social responsibility, while agrarian technicians can lead sustainability initiatives within their communities. The study advocates curriculum revisions to integrate comprehensive sustainability education, equipping students with the tools to tackle complex sustainability challenges. By fostering a profound recognition of the interconnectedness of environmental, social, and economic systems, educational institutions can empower students to drive transformative change. These insights offer a foundation for enhancing environmental education initiatives, raising awareness about sustainability issues, and empowering future professionals to adopt eco-friendly behaviors, paving the way for a more sustainable and resilient future. Future research should focus on exploring disparities between rural and urban settings to tailor education and policy development to the diverse needs of various communities.

Keywords: Sustainable Development Goals; TVET students; graduate students; rural development; SDGs awareness; educational disparities.

CONECTANDO PERSPECTIVAS: UM ESTUDO COMPARATIVO DAS PERSPECTIVAS DOS OBJETIVOS DE DESENVOLVIMENTO SUSTENTÁVEL ENTRE ESTUDANTES AVANÇADOS E TÉCNICOS

RESUMO

Este estudo investiga as perspectivas de estudantes em educação agrícola e rural sobre os Objetivos de Desenvolvimento Sustentável (ODS), comparando duas grupos: estudantes do ensino médio do curso técnico agrícola e estudantes de pós-graduação na área de desenvolvimento. Utilizando questionários estruturados administrados via Google Forms, a pesquisa examina a conscientização, compreensão e a importância atribuída a cada ODS por esses estudantes. A análise dos dados, empregando estatísticas descritivas, teste t de Welch e testes inferenciais, revela disparidades significativas nas percepções entre os dois grupos. Estudantes de pós-graduação exibem uma compreensão mais robusta e atribuem maior importância aos ODS em comparação com seus colegas técnicos agrícolas, que demonstram pontos de vista mais conservadores. Ambos os grupos, no entanto, enfatizam ODS específicos relacionados à agricultura e energia limpa, especialmente em ambientes terrestres. Os resultados destacam o papel crítico da integração da sustentabilidade nos currículos para aumentar a conscientização, empoderar os estudantes e promover práticas sustentáveis. Enfatizar o consumo e comportamentos sustentáveis pode aprofundar a compreensão dos estudantes sobre a necessidade de consumo sustentável, especialmente no que diz respeito a recursos não renováveis, como combustíveis fósseis e fertilizantes químicos. O estudo também ressalta a necessidade de abordagens holísticas para a educação em sustentabilidade que abranjam dimensões ambientais, sociais e econômicas, preparando os estudantes para contribuir ativamente para o desenvolvimento sustentável. Lacunas notáveis no conhecimento, especialmente nos aspectos sociais e econômicos da sustentabilidade, sugerem a necessidade

de abordagens educacionais integradas. Abordar essas lacunas é essencial para desenvolver programas educacionais inclusivos e eficazes, garantindo que futuros educadores possam promover a responsabilidade ambiental e social, enquanto técnicos agrícolas podem liderar iniciativas de sustentabilidade dentro de suas comunidades. O estudo defende revisões curriculares para integrar uma educação em sustentabilidade abrangente, equipando os estudantes com as ferramentas para enfrentar desafios complexos. Ao promover um reconhecimento profundo da interconexão dos sistemas ambientais, sociais e econômicos, as instituições educacionais podem capacitar os estudantes a promoverem transformações. Estes insights oferecem uma base para aprimorar as iniciativas de educação ambiental, aumentar a conscientização sobre questões de sustentabilidade e capacitar futuros profissionais a adotarem comportamentos ecologicamente corretos, pavimentando o caminho para um futuro mais sustentável e resiliente. Pesquisas futuras devem se concentrar em explorar disparidades entre contextos rurais e urbanos para adaptar o desenvolvimento educacional e de políticas às diversas necessidades das comunidades.

Palavras-Chave: Objetivos de Desenvolvimento Sustentável; Alunos TVET; estudantes de pós-graduação; Desenvolvimento Rural; Conscientização sobre os ODS; Disparidades educacionais.

1- INTRODUCTION

Over the past few years, the Sustainable Development Goals (SDGs) set by the United Nations have become a prominent global framework for tackling urgent societal and environmental issues. Encompassing a broad spectrum of objectives, from ending poverty and hunger to promoting environmental sustainability and ensuring quality education for all, the SDGs serve as a blueprint for collective action towards a more equitable and sustainable future (UN, 2015).

While considerable research has delved into the worldwide implications of the SDGs and strides have been taken to measure their progress (Sachs et al., 2021, 2023), there is a growing recognition of the imperative to prioritize localized viewpoints, particularly in rural areas. This pivot echoes the age-old mantra Think globally, act locally, often attributed to Patrick Geddes, (Meller, 2005). While the exact origin of the phrase within Geddes's works may be elusive, it encapsulates the essence of his philosophy, which emphasized the importance of considering global issues while taking action at the local level to effect meaningful change (Geddes, 1895). This underscores the significance of customizing developmental endeavors to suit the distinct circumstances and requirements of rural populations.

The emphasis on localized perspectives in SDGs initiatives intersects significantly with education, since education enhances labor productivity and innovation capacity, which are essential for economic growth, poverty reduction, and overall sustainable development (Amorós Molina et al., 2023; Makinde et al., 2024; Rulandari, 2021; F. P. Soares et al., 2023; Vladimirova & Le Blanc, 2015), especially on shaping the way students learn about and engage with sustainable development efforts.

Prioritizing localized perspectives in education allows educators to customize curriculum content and teaching methods according to the unique needs, challenges, and

aspirations of rural communities. This tailored approach promotes a more meaningful and immersive learning environment, empowering students to comprehend and actively participate in Sustainable Rural Development (SRD) initiatives, while integrating SDGs into education equips students with essential knowledge and skills, enabling them to become catalysts for positive change (Gardiner, 2008; Olobia, 2023; Valenzuela-Chapetón, 2023; Zaidan Esmatand Belkhiria, 2023).

By preparing students to address pressing societal and environmental issues within their local contexts, this educational approach fosters a generation of informed and proactive individuals poised to make a difference (Almusalami et al., 2024). The research field concerning SDGs and students' perspectives is witnessing a surge of interest and acknowledgment (Ho et al., 2022; Koçulu & Topçu, 2024; Ohta et al., 2022). In this context, education serves as a dual-purpose tool for youth, not only heightening their awareness of sustainability issues but also equipping them with the skills necessary to actively implement sustainable development practices (Jones et al., 2024).

In the pursuit of sustainable development, understanding the perceptions, priorities, and knowledge of diverse stakeholders is paramount for effective action and meaningful progress (Ureta et al., 2021). Central to this endeavor are the voices and perspectives of young individuals, who represent both the inheritors and architects of our collective future. Within rural contexts, where development challenges intersect with unique socioeconomic and environmental dynamics, the engagement and empowerment of the future educators and extension agents are of particular significance.

Rural communities often face unique challenges in achieving sustainable development, including limited access to resources, infrastructure, educational opportunities and governmental polices (Matte et al., 2016; Medina & Barbosa, 2023). Agrarian Technicians represent a vital demographic, with the potential to drive positive change within their

communities and contribute to the broader SDG agenda. However, their perspectives, aspirations, and priorities regarding sustainable development goals remain relatively understudied (Kleespies & Dierkes, 2022).

Teachers play a pivotal role in influencing the awareness of SDGs among students (Nketsia et al., 2020). Through various strategies such as integrating SDGs into the curriculum, facilitating classroom discussions, organizing project-based learning activities, providing experiential learning opportunities, and serving as role models, teachers effectively raise awareness and foster understanding of the goals among students (Lei & Tang, 2023).

By engaging students in these approaches, teachers not only impart knowledge about the SDGs but also inspire them to become active participants in achieving sustainable development both locally and globally. Recognizing the importance of teachers in this regard enables the development of targeted training programs that equip them with the necessary knowledge and skills to effectively integrate SDGs into their teaching practices. Furthermore, by aligning educational content with the interests and concerns of these future educators, educational institutions ensure that they are adequately prepared to engage their students in meaningful discussions and activities related to sustainable development.

Similarly, for agrarian technicians working within rural communities, understanding their perspectives on SDGs is crucial for designing training programs that empower them to implement sustainable development initiatives effectively. By tailoring educational content to address the specific challenges and opportunities faced by agrarian technicians in rural settings, training programs can equip them with practical tools and strategies to promote sustainability within their communities.

Agrarian technicians who engage in rural extension play a pivotal role in advancing SDGs within rural communities. These professionals serve as vital conduits between agricultural practices and sustainable development initiatives, facilitating the dissemination of

knowledge, techniques, and technologies that promote environmental stewardship, social equity, and economic prosperity (Marassiro et al., 2020). Through their outreach efforts, agrarian technicians empower rural stakeholders to adopt sustainable agricultural practices, mitigate environmental degradation, enhance food security, and improve livelihoods (Rwamigisa et al., 2023). By bridging the gap between scientific knowledge and local realities, agrarian technicians contribute significantly to the achievement of SDGs, fostering resilient and inclusive rural development pathways (Hiroyuki Takeshima et al., 2023). Their integral role underscores the importance of investing in their training, capacity-building, and institutional support to maximize their impact on sustainable development outcomes.

Understanding the diverse perspectives on SDGs among advanced students, who are poised to become teachers, and Agricultural Technical Vocational Education and Training (TVET) students is crucial for customizing educational programs and curricula to address the distinct needs and interests of each group. Through a comprehensive understanding of their perspectives, educators can develop educational materials and teaching methodologies that align with the unique experiences and backgrounds of future teachers and agrarian technicians, ensuring greater relevance and effectiveness in promoting awareness and engagement with the SDGs.

Given that these students will be the professionals of the near future, this article endeavors to bridge this gap by investigating the perceptions of SDGs through an exploration of their comprehension of these global objectives. By understanding the perspectives and priorities of these students concerning the SDGs, we can identify strategies to effectively involve them in initiatives aimed at achieving sustainable development goals, thereby fostering inclusive and impactful efforts towards a more sustainable future.

This study sets out to explore and compare the perspectives and understanding of the SDGs among two distinct groups: students enrolled in agriculture vocational educational and

training (Agrarian Technicians) and those pursuing advanced degrees in sustainable development (Advanced Students). By delving into the perceptions and knowledge of these cohorts, we aim to uncover insights that can inform strategies for promoting sustainable development within rural communities and advancing the global SDG agenda.

Through this comparative analysis, we aspire to not only deepen our understanding of secondary and tertiary level students' perspectives on SD but also to catalyze actionable strategies and policies that empower them as agents of change within their communities and beyond. In doing so, we reaffirm the importance of inclusive and participatory approaches in realizing the transformative potential of the SDGs and building a more equitable and sustainable future for all.

2- METHODOLOGY

For this article, two groups of students from Brazil were selected. The first group consisted of 242 high school students enrolled in an integrated agricultural technician course in the second and third grades at the State Agricultural College of Toledo (CAET), while the second group comprised 248 master's and doctoral students focusing on rural development. The cohort selection was based on the perception that in Brazil, most advanced students become teachers, and the way teachers understand and consider sustainability issues is reflected in how future generations will understand and consider these issues. As a result, when discussing sustainability, it is crucial to consider the perspectives of these future educators. When talking about TVET agrarian students, we recognize that these students could be responsible for implementing many sustainable agriculture practices in their field of work, making them essential for the sustainability of the agricultural sector.

The State Agricultural College of Toledo (CAET) was selected for this study due to its prominent role in agricultural education in the region of Toledo, Paraná in the south region of Brazil. As a specialized institution focusing on TVET agricultural sciences and technologies, CAET offers a curriculum that integrates both theoretical knowledge and practical skills in agrarian studies.

The college provides an ideal setting for studying sustainability in agriculture due to its emphasis on practical learning experiences and its commitment to environmental stewardship. Additionally, the geographical location of CAET in Toledo, a region known for its agricultural production, provides a relevant context for exploring the relationship between education and sustainable rural development. Studying at CAET allows for insights into how agricultural education can contribute to sustainable practices and rural development in the context of Paraná.

Survey design and procedures.

After completing the documentary research for the previous article, we developed a comprehensive questionnaire with open-ended, descriptive, and multiple-choice questions, using the Google Forms platform.

The main purpose of this form was to obtain a deep understanding of students' perceptions regarding sustainable agriculture, sustainability, and their views on the importance of the sustainable development goals for general welfare, based on the studies of (Akçay et al., 2024; Chankseliani & McCowan, 2021; Ho et al., 2022; Jones et al., 2024; Kleespies & Dierkes, 2022; Koçulu & Topçu, 2024; Lei & Tang, 2023; Ohta et al., 2022; UN, 2022; Yuan et al., 2021). Through these questions, we aimed to capture the perspectives and knowledge of the students on these topics to enrich our analysis and contribute to a more comprehensive view of issues related to the approaches of the SDGs by schools.

Data collection and sample

For that, two distinct questionnaires were developed, one for Advanced Students and another for TVET students, tailored to the specific context and language of each group. The questionnaires can be found in the appendix section.

The questionnaire was administered to advanced students using the online survey platform, Google Forms, to facilitate data collection and analysis. Advanced students received their questionnaire via email and completed it during scheduled class sessions. To ensure the quality of responses and clarify any doubts, clear guidelines were provided. Participation was voluntary, and data was collected over a two-week period.

From the questionnaire available on appendix 1, a sample of 242 students was obtained. Of the students surveyed, 132 (54.3%) are male and 106 (43.6%) female, and 5 (2.1%) were gender non-specific. The age of respondents varies between 15 and 17, but the highest response rate was in the 16 range. Most respondents were in the second grade 125 (51.7%) and 116 (48.3%) were graduating seniors (Third grade).

From que questionnaire available on appendix 2, a sample of 248 advanced students was obtained. Of the students surveyed, 143 (57,6%) are female and 105 (42,4%) males. The age of respondents varies between 22 and 64, but the highest response rate was in the 26 range. Most respondents were pursuing their master's degree 128 (51.61%) and 120 (48.39%) their doctorate degrees.

Throughout the study, utmost care was taken to uphold ethical standards. Informed consent was diligently obtained from all participants, with assurances of anonymity, confidentiality, and secure data storage for research purposes.

Structured questionnaires with open and closed-ended questions, using the Likert-type scale (DeVellis, 2016; Jamieson, 2005), were administered through the Google Forms tool, a detailed and objective tool for assessments (Komperda, 2017). The data obtained were organized on the platform itself using the online spreadsheet program. Subsequently, with the

assistance of R-Studio (R-studio, 2022), the data underwent descriptive analysis (Komperda, 2017).

Statistical analysis

By employing a rigorous mixed-methods approach, this study aims to provide valuable insights into TVET agrarian and advanced students' perceptions of the importance of the sustainable development goals. The combination of curriculum analysis and questionnaire survey allows for a comprehensive exploration of students' perspectives, contributing to the ongoing discourse on sustainability education and its implications for agricultural training and practice.

The analysis commenced by calculating descriptive statistics (including mean, median, and standard deviation) separately for each group. This facilitated an understanding of the distribution and central tendencies of the responses to questions related to SDGs (Maravelakis, 2019).

Descriptive statistics were used to analyze demographic data, including age distribution, gender distribution, religious affiliation, and residential background. The Shapiro-Wilk test was conducted to assess the normality of the data, and non-parametric statistical tests were used due to non-normal distributions.

Participants' awareness and knowledge levels of SDGs were analyzed using descriptive statistics. The Wilcoxon rank sum test was employed to compare awareness and knowledge levels between Agrarian Technician Students and Advanced Students.

Participants were asked to rank the perceived importance of each SDG for the nation's overall welfare on a scale of 1 to 4. Mean scores were calculated to compare the perceived importance levels of SDGs between Agrarian Technician Students and Advanced Students. The

Mann-Whitney U test (Wilcoxon rank sum test) was used to analyze the differences in perceived importance levels between the two student cohorts.

Correlation analyses were conducted to explore the relationships between different aspects of sustainable development, including SDGs, awareness, and knowledge levels. Spearman's Rank Correlation was used to identify nonlinear correlations between SDGs and other variables. Correlation matrices were generated to visualize and interpret the strength and direction of relationships among variables.

The correlation matrix emerges as a cornerstone tool, wielding significant influence in uncovering hidden relationships within datasets. By scrutinizing variables and their interplay, researchers gain invaluable insights into the dynamics shaping their data. The correlation matrix serves as a robust mechanism for unveiling the intricate web of connections between variables, facilitating the identification of patterns, trends, and dependencies that might otherwise remain obscured.

The nonparametric Spearman’s Rank Correlation analysis was conducted in this study to determine the relationship between each SDG (Spearman, 2010). Since the data are nonlinearly correlated, Spearman’s analysis was chosen as it is less sensitive to outliers (Hauke & Kossowski, 2011). The correlation analysis was performed using research data from the questionnaire applied to both students’ cohorts regarding the 17 SDGs, their SDG awareness (ASDG), and SDG knowledge (KSDG). These results elucidate the synergies and trade-offs among the SDGs and aid institutions in future planning.

Finally, results were interpreted to identify significant findings and trends in demographic characteristics, awareness, knowledge, and perceptions of SDGs among Agrarian Technician Students and Advanced Students. The implications of the findings were discussed in the context of promoting sustainable development initiatives and educational strategies tailored to the needs of different student populations.

However, it's important to acknowledge potential limitations. Factors such as sample size and participant demographics may impact the generalizability of our findings. Additionally, self-reporting bias and social desirability bias could influence participants' responses, while the cross-sectional design of the study may constrain our ability to establish causal or temporal relationships between variables. The obtained data is presented and discussed below.

3- RESULTS AND DISCUSSION

Demography

The demographic analysis in Table 4, provides insights into the age, gender, religious affiliation, and residential backgrounds of both technical and advanced students, which can be valuable for understanding their characteristics and tailoring educational or developmental initiatives to their specific needs and circumstances.

Understanding these demographic characteristics is crucial for contextualizing the study findings and ensuring that interventions or educational approaches are appropriately tailored to meet the needs of the target student populations. By acknowledging and accounting for these demographic differences, researchers and educators can develop more effective strategies for promoting awareness, understanding, and action related to sustainability among students. This holistic approach helps ensure that initiatives are inclusive, relevant, and responsive to the diverse needs and contexts of the student population.

Table 4 - Demographic categorization.

Characteristics	Study level	Aspects	Percentage
Age	Technical	16–20	100
	Advanced	21–25	6.4
		>25	94.6
Gender	Technical	Female	43.6
		Male	54.3
		Neither	2.1
	Advanced	Female	57.6
		Male	42.4
Religion	Technical	Yes	98.4
		No	1.6
	Advanced	Yes	60.8
		No	39.2
Residence	Technical	Rural	14.5
		Urban	49.4
		Both	36.1
	Advanced	Rural	4.7
		Urban	89.8
		Both	5.5

Source: The Authors (2024)

Among technical students, there is a relatively balanced gender distribution, with slightly more males (54.3%) than females (43.6%). Advanced students also have a balanced gender distribution, but with a higher percentage of females (57.6%) compared to males (42.4%).

Technical students have a varied residential background, with a significant portion living in urban areas (49.4%), followed by those living in both rural and urban areas (36.1%), indicating that they have to stay in the city during the week, to study and go home to the rural areas on the weekends, in this sense, only (14.5%) are from rural areas and are able to come and go every day. According to (Wilfred Mncube et al., 2023) this arrangement may reflect the limited availability of educational resources and institutions in rural areas, implicating in students having to commute for academic pursuits.

Conversely, advanced students predominantly reside in urban areas (89.8%), indicating that they are more likely to have continuous access to urban educational facilities without the need for frequent commuting or relocation. The smaller percentages of advanced students residing in both rural and urban areas (5.5%) or rural areas alone (4.7%) suggest that a smaller proportion of this group faces challenges related to rural-urban mobility or access to urban educational resources.

The higher proportion of students residing in urban areas, combined with a significant portion living in both rural and urban areas, suggests that they may have migrated from rural to urban areas in pursuit of educational opportunities not available in their rural hometowns. This pattern aligns with the phenomenon of rural-urban migration, where individuals move from rural to urban areas in search of better access to education, employment, and other amenities.

According to Wilfred Mncube et al. (2023) limited school resources in rural areas can indeed contribute to migration. When rural schools lack essential resources such as qualified teachers, adequate facilities, and educational materials, families may choose to migrate to urban areas in search of better educational opportunities for their children. This phenomenon, known as educational migration, can further strain resources in urban schools while leaving rural schools with even fewer students and resources, creating a cycle of resource depletion in rural areas. Additionally, the lack of quality education in rural schools may lead to a perception of limited opportunities for students, prompting them to seek education and employment prospects in urban centers, ultimately contributing to migration trends.

Data distribution

To assess whether a normal distribution was followed by the data, both statistical tests and visual inspections were employed. The data were visually examined with a Q-Q plot and a

histogram (appendix 5). Subsequently, the Shapiro-Wilk test, a statistical test for normality, was performed.

Data analysis

The Shapiro-Wilk tests for normality were conducted on both groups of students:

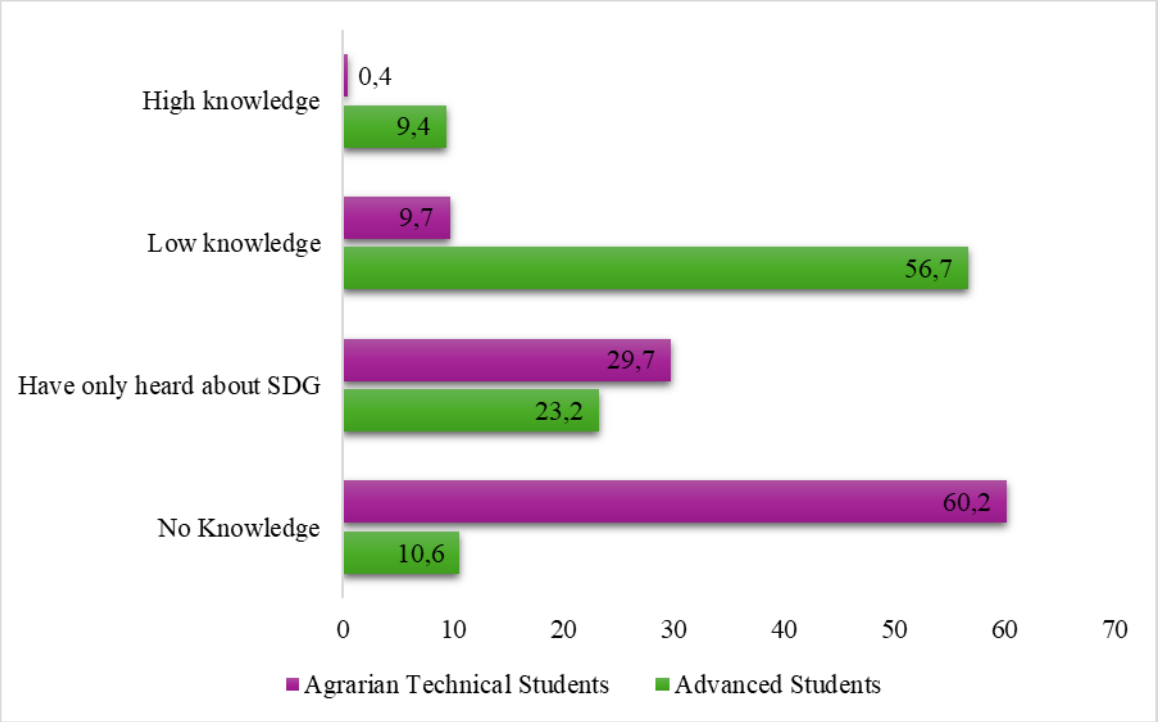
For the group of Advanced Students, the test statistic (W) was approximately 0.86101, with a p-value of 0.01586. For the group of Agrarian Technical Students, the test statistic (W) was approximately 0.86491, with a p-value of 0.01825. In both cases, the p-values were less than 0.05, indicating rejection of the null hypothesis of normality.

Therefore, based on the Shapiro-Wilk tests, there is evidence to suggest that neither group's data comes from a normally distributed population, which is common when testing hypothesis from questionnaire-based research. As a result, we proceeded to use non-parametric statistical tests.

The initial aspect we investigated pertained to the students' perceived familiarity with the Sustainable Development Goals (SDGs). To assess this, participants from both cohorts were requested to rank their understanding on a scale of 1 to 4, with 1 representing no familiarity, 2 indicating awareness but lacking detailed knowledge, 3 signifying modest knowledge, and 4 denoting extensive knowledge.

The data (Figure 1) reveals significant disparities in awareness and knowledge levels about Sustainable Development Goals (SDGs) between Agrarian Technician Students and Advanced Students.

Figure 3- Knowledge about the SDGs distribution between Agrarian Technical Students and Advanced Students.



Source: The Authors (2024)

The Wilcoxon rank sum test with continuity correction was conducted on the data, a (W) of 9575 was obtained, along with a p-value smaller than 0.05. This indicates that there is a statistically significant difference between the groups. A majority (60.2%) of Agrarian Technician Students have never heard about SDGs, whereas only a minority (10.6%) of Advanced Students fall into this category. There is a notable difference in awareness levels between the two groups, this suggests that Agrarian Technician Students may have less exposure to or emphasis on global sustainable development initiatives compared to Advanced Students.

Almusalami et al. (2024) investigating the awareness of the SDG among university students in the United Arabic Emirates, found that a large proportion of the participants, 49%,

had no idea of what the 17 SDGs are. The distribution across knowledge levels varies significantly between the two groups. While the majority (56.7%) of Advanced Students report having some knowledge about SDGs, a smaller proportion (9.7%) of Agrarian Technician Students fall into this category. Conversely, a larger percentage (29.7%) of Agrarian Technician Students report having heard of SDGs but not knowing much about it compared to Advanced Students (23,2%).

Interestingly, there are also disparities in the percentage of students reporting extensive knowledge about SDGs between the two groups (9.4% for Advanced Students and 0.4% for Agrarian Technician Students). This suggests that there may be significant differences in overall awareness and fundamental knowledge levels across both cohorts.

The data corroborates the findings of (33), for them, many students require assistance in grasping and connecting the broader spectrum of sustainability concepts. Although the present study revealed significant interest in sustainability issues, it highlighted the necessity for the development and inclusion of more targeted and subject-specific modules within the curriculum so as to broaden students' perspectives.

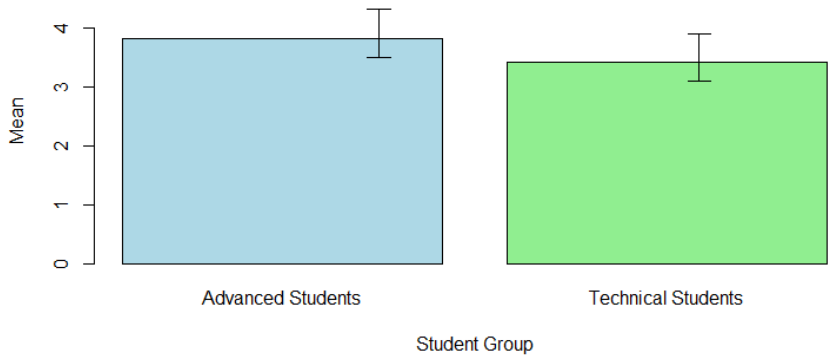
Importance of the SDGs

To assess the importance attributed to the Sustainable Development Goals (SDGs) by the participants, they were asked to rank the perceived significance of each goal for the nation's overall welfare in. A rating scale was provided, where a score of 1 represented “not important at all,” 2 indicated a “low level of importance”, 3 denoted “uncertainty or a preference to abstain” from providing an opinion, and 4 signified “high importance”.

Afterwards, the mean data resulting from the statistical analyses were processed and is presented below (Figure 4). These results illuminate a shared recognition among both advanced and technical students of the critical role the SDGs play in promoting national welfare,

highlighting a unified commitment towards sustainable development goals within educational settings. In terms of sample estimates, the mean importance level of advanced students (3.82) is slightly higher than that of technical students (3.42) (Figure 2), suggesting that advanced students perceive the SDGs to be more important for the nation's welfare compared to technical students.

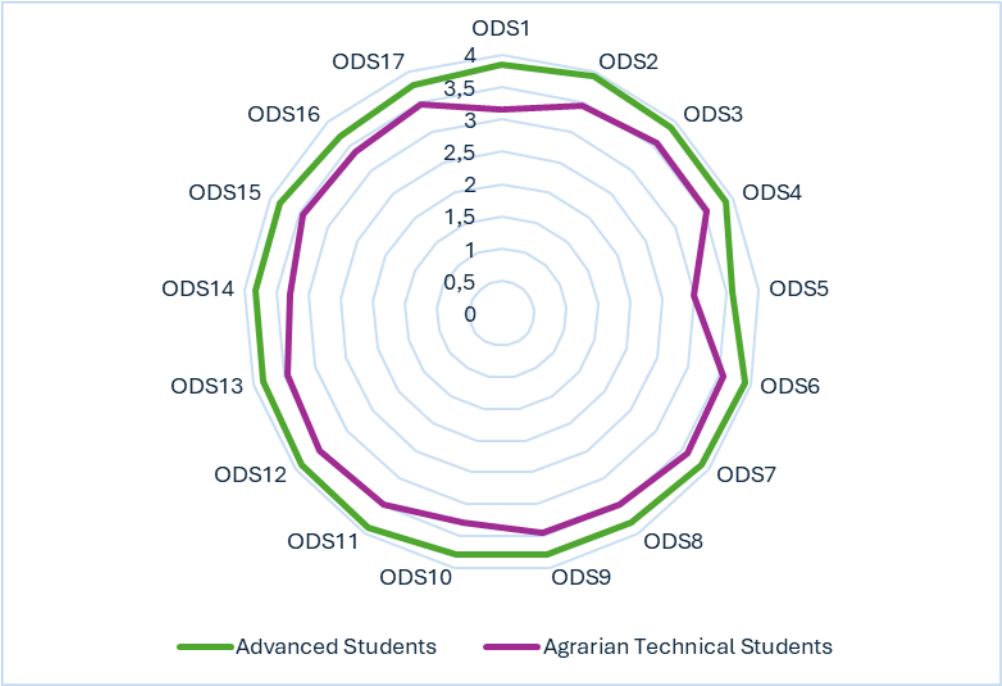
Figure 4- The mean importance level by cohort.



Source: The Authors (2024)

Both cohorts were examined to determine if they were in fact statistically uneven. For that, a Mann-Whitney U test, was performed. The data indicates that there is a statistically significant difference between the means of the two cohorts, and so, a highly significant difference between the two groups for all the variables, implying that there is a substantial distinction in the perceived importance levels of the SDGs between advanced students and technical students Figure 5.

Figure 5- SDG importance for advanced students and agrarian TVET students.



Source: The Authors (2024)

The data on the perceived importance levels of the SDGs between advanced students and TVET students is summarized on table 5.

Table 5- SDG importance by each cohort.

SDG | Goal Description	**Importance Level**	
	Advanced Students	**Technical Students**
| SDG 1 | No Poverty	3.85	3.16
|SDG 2 | Zero Hunger and Sustainable Agriculture	3.92	3.45
| SDG 3 | Good Health and Well-being	3.89	3.56
| SDG 4 | Quality Education	3.87	3.55
| SDG 5 | Gender Equality	3.58	3.00
| SDG 6 | Clean Water and Sanitation	3.92	3.57
| SDG 7 | Affordable and Clean Energy	3.88	3.60
| SDG 8 | Decent Work and Economic Growth	3.80	3.48
| SDG 9 | Industry, Innovation, and Infrastructure	3.79	3.46
| SDG 10 | Reduced Inequality	3.80	3.29

SDG 11	Sustainable Cities and Communities	3.90	3.47
SDG 12	Responsible Consumption and Production	3.88	3.53
SDG 13	Climate Action	3.83	3.45
SDG 14	Life Below Water	3.82	3.28
SDG 15	Life on Land	3.84	3.43
SDG 16	Peace and Justice Strong Institutions	3.70	3.37
SDG 17	Partnerships for the Goals	3.78	3.46

Source: The Authors (2024)

These rankings underscore the shared emphasis of both cohorts on objectives related to food security, access to clean water, and sustainable urban development. Nevertheless, discernible differences emerge in the degree of importance accorded to each goal. To facilitate a comprehensive examination, we have selected SDG 2, SDG 5, and SDG 7 for in-depth analysis, aiming to elucidate distinct perspectives and priorities within the studied demographics.

3.1 GOAL 2 ZERO HUNGER AND SUSTAINABLE AGRICULTURE

Brazil has made noteworthy progress in reducing hunger and poverty over the past few decades, with the implementation of social programs such as “Bolsa Família”, which provides conditional cash transfers to low-income families, and the National School Feeding Program, which provides free meals to schoolchildren (Chen et al., 2023; Fiszbein et al., 2009; F. V. Soares et al., 2006). These programs have helped alleviate poverty and improve access to food for millions of Brazilians (Nazareno & de Castro Galvao, 2023), contributing to progress towards achieving SDG 2.

However, challenges remain in ensuring food security and nutrition for all Brazilians (da Costa Louzada et al., 2023; Dewan et al., 2024; Santos et al., 2023). Inequality, unemployment, and social exclusion continue to limit access to nutritious food for many,

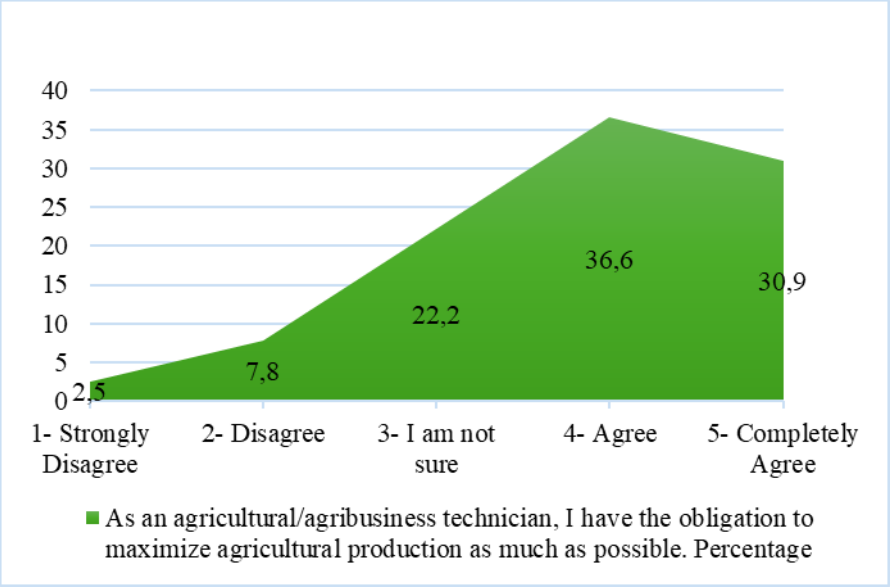
particularly in marginalized communities and rural areas (Matte et al., 2022). Additionally, environmental degradation, climate change, and natural disasters pose threats to agricultural productivity and food production, exacerbating food insecurity and hunger in some regions.

Undoubtedly, both cohorts, comprised of Advanced Students (with an importance level of 3.92) and Technical Students (with an importance level of 3.45), demonstrated a appreciation for the Sustainable Development Goal of Zero Hunger and Sustainable Agriculture.

This finding underscores the universal acknowledgment of the imperative to ensure food security and promote sustainable agricultural practices. The considerable importance attributed to this goal by both groups indicates a shared recognition of agriculture's pivotal role in addressing global hunger and fostering sustainable development.

To assess students' perceptions of the role of their profession in relation to SDG2, students were asked to rank the following sentence “As an agricultural/agribusiness technician, I have the obligation to maximize agricultural production as much as possible” on the Likert scale (Figure 6).

Figure 6- Productivistic Professional Responsability.

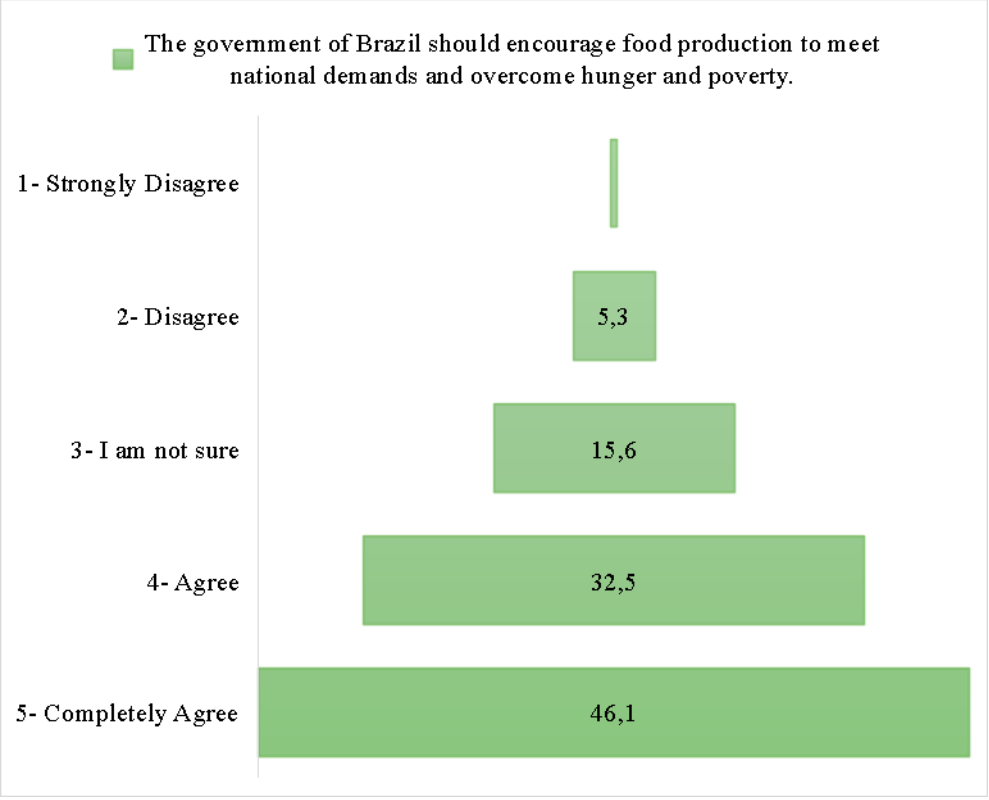


Source: The Authors (2024)

Analysis of the question above and the open-ended questions regarding the subject revealed a notable trend among technical-level students, who predominantly emphasized the importance of agricultural production. Many students expressed a belief that it is their responsibility to contribute to feeding the world, often suggesting that the government should incentivize food exportation and focus on enhancing production efficiency.

Additionally, recurring responses highlighted the students' belief in the government's role in stimulating food production to enhance national food security (Figure 7).

Figure 7- Food Security and Poverty Alleviation.



Source: The Authors (2024)

TVET students appear to be primarily concerned with the production aspect of this goal. While they acknowledge the importance of food production and, in some cases, recognize the

need for food security, they do not seem to fully grasp the significance of ensuring universal access to food. Their perspectives on the social issues surrounding food distribution seem to be more conservative, as they attribute the problem of food scarcity solely to food production.

Students seem to align with the general myth of the agricultural sector that states the moral obligation of agriculture on “feeding the world”.

Stone (2022) challenges the prevailing narrative surrounding the Green Revolution, in which a discourse of the need to increase production at any cost is necessary to feed the poor and hungry. The author argues that it did not significantly increase food security, instead food production relied heavily on inputs like fertilizers and pesticides, failing to address the root causes of food insecurity and overproduction.

The concept of Industrial Neo-Malthusianism is also scrutinized, with Stone (2022) questioning the emphasis on increasing food production through industrial technologies. He argues that this approach has led to overproduction and in a more worrying note, decreased farmer self-reliance

These finding also align with Schragmann (2024), according to the author, this discourse endorses the current use of intensive tilling methods that harm the soil, fertilizers that may cause health issues, and the deterioration of humus due to insufficient regeneration periods. By neglecting these concerns, the rhetoric of “feeding the world” presents an incomplete picture. Ultra-modernized agriculture fails to consider the long-term effects of current practices on soil health, biodiversity, and human health. This is a significant flaw, as increasing short-term productivity may jeopardize the conditions necessary for future productivity in numerous ways.

In accordance with what is discussed by Salles-Costa et al. (2023) despite Brazil's high commodity productivity, poverty alleviation and food security in rural areas remain significant challenges. Despite the country's agricultural prowess, the lack of adequate monitoring and evaluation of food insecurity levels perpetuates the disconnect between high commodity

productivity and the well-being of rural populations (Salles-Costa et al., 2023). Thus, while Brazil may excel in agricultural output, the benefits do not necessarily trickle down to rural areas, highlighting the need for comprehensive strategies that address the underlying socio-economic and environmental factors contributing to rural poverty and food insecurity.

Stone (2022) also highlights the role of government subsidies in driving overproduction and industrialization in agriculture. He contends that these subsidies disproportionately benefit certain industries, and certain type of farmers, leading to negative outcomes for food systems and the environment.

Educational initiatives and curricular enhancements aimed at promoting awareness and understanding of these social dimensions connected to our food insecurity, are essential to ensure that students are equipped with the knowledge and skills necessary to contribute effectively to sustainable development efforts. By emphasizing the interconnectedness of environmental, social, and economic dimensions, educators can empower students to address sustainability challenges comprehensively and promote meaningful change in their communities and beyond.

Establishing partnerships with local communities, NGOs, businesses, and government agencies to collaborate on SDG-related projects is identified as another crucial strategy for education institutions. These partnerships provide students with hands-on learning opportunities and enable them to see real-world impacts while contributing to sustainable solutions. Additionally, encouraging students to engage in extension and research projects, internships, and initiatives focused on specific SDGs could offer practical experience as well as enhance their understanding of sustainability challenges related to food.

3.2 GOAL 5 GENDER EQUALITY

While students demonstrate a strong grasp of the significance of environmental-related goals, such as those pertaining to environmental preservation and sustainable agriculture, their understanding of social justice and gender equality goals appears to be less pronounced in Table 5. This observation suggests a potential imbalance in awareness and prioritization among students regarding different aspects of sustainable development.

The findings regarding gender equality as perceived by advanced students and technical students reveal notable differences in their prioritization of this SDG. Advanced students, with an average importance level of 3.58, express a higher level of concern for gender equality compared to technical students, whose average importance level is 3.00. This discrepancy suggests that advanced students may perceive gender equality as a more crucial aspect of sustainable development compared to their counterparts in technical programs. However, both groups fall short of ranking gender equality as highly as other SDGs, indicating a potential area for improvement in understanding and addressing gender-related issues within educational settings.

Discrimination against women and girls remains a widespread issue worldwide (Beloskar et al., 2024; Kemechian et al., 2023; Leach et al., 2016). Valduga et al. (2023) argues that despite global initiatives to tackle this problem, many gender-discriminatory laws still exist, preventing women from fully enjoying their fundamental human rights. To close the gender gap, it is crucial for society, governments, and organizations to adopt a comprehensive and strategic tool to effectively address gender disparities. However, there is currently a lack of a specific management system designed to achieve this goal. Developing an effective strategy requires a thorough analysis and understanding of the various factors that hinder progress towards gender equality.

These findings underscore the importance of promoting awareness and education on gender equality to foster more inclusive and equitable societies, both within higher education

institutions and beyond. The collective data was analyzed to investigate whether gender influences students' perceptions of the Sustainable Development Goals (SDGs), yielding surprising findings in Table 6.

Table 6- Gender effect on SDG perception

Welch Two Sample t-test	Male	Female
Mean	3.496	3.514
Observations	238	247
t -0.9338		
df 8706.4		
p-value 0.3504		
95% confidence interval -0.05476740,0.01942452		

Source: The Authors (2024

The analysis found that there was no statistically significant difference in the mean SDG scores between males and females ($t = -0.9338$, $p = 0.3504$). This means that, based on the data, there is insufficient evidence to conclude that there is a meaningful difference in how males and females perceive the importance of the Sustainable Development Goals (SDGs) to societal well-being.

The study's Welch Two Sample t-test, reveal a notable departure from existing literature by indicating that gender does not significantly influence sustainability behaviors and habits among the interviewed students. This finding contradicts previous research, such as the study by Aslam et al. (2022), who emphasized a greater inclination among women in higher education institutions towards engaging in sustainable practices compared to men. Aslam et al. (2022) observed a heightened propensity for sustainability interests and pro-environmental behaviors among women, thus aligning with the findings of this study.

This inequality is also reflective of the persistently male-dominated rural landscape in the country (Litre et al., 2023; Matte et al., 2021). Despite the implementation of targeted public

policies for women, such as PRONAF Mulher (Spanevello et al., 2016), the effectiveness of these initiatives remains limited, as indicated by low performance indicators. Additionally, the data highlight the need for targeted interventions and educational initiatives to empower students to advocate for gender equality and contribute to its realization in their communities and professional fields.

Research indicates that discussions around gender and related issues can be considered taboo among women in rural areas for several reasons. Cultural norms and traditional gender roles play a significant role in shaping attitudes towards gender discussions. In many rural communities, these discussions are often influenced by deeply entrenched patriarchal values, where gender roles are rigidly defined and questioning them can be seen as challenging the social order (Mosha et al., 2013).

Additionally, the fear of social ostracism and backlash from the community can discourage women from engaging in conversations about gender equality (Vogel et al., 2022). Moreover, women in rural areas often face significant barriers in accessing platforms where they can freely discuss these topics. This lack of safe spaces for open dialogue further perpetuates the silence around gender issues. In many cases, discussing gender roles and rights can also be seen as secondary to more immediate concerns such as economic survival and family welfare, which are often prioritized in rural settings (Mosha et al., 2013; Vogel et al., 2022).

Perhaps, the lack of importance to the goal perpetrates the need for addressing the significance of this goal for women daily life. The results seem to go in the same direction as those obtained by Herbert et al. (2022), despite increasing calls for consideration of sex and gender in research and policy, the proportion of publications addressing these topics remained relatively steady over time, indicating a need for greater attention to this issue on gender within the SDGs.

This issues on the policy implementation may be related to the worldwide issue of women and the right to land. Ingwani (2021) explores the struggles of women in peri-urban communal areas in Zimbabwe to access and hold land property rights under customary tenure systems. The study shows that women's inability to secure land rights is often due to patriarchal social structures and customary land tenure practices that favor men. The research underscores the need for legal recognition and enforcement of women's land rights to promote gender equality and economic stability in these regions.

Stanley & Lisher (2023) highlights the critical role of women's land rights in achieving gender equality and economic development. These reports detail how secure land rights for women can lead to increased agricultural productivity, improved family welfare, and broader economic growth. They also emphasize the need for legal reforms and policy measures to remove barriers that prevent women from owning land

Specific case studies, such as those conducted in India and China, illustrate the tangible impacts of improved land rights for women. For instance, a study in India highlights how digital land records and amendments in policies have begun to improve women’s land ownership, although challenges remain. Similarly, research in China shows how legal reforms allowing women to lease land have positively affected labor allocation and economic outcomes (Namubiru-Mwaura, 2014).

That said, the data underscores the importance of integrating sex and gender considerations across all SDGs to ensure that gender perspectives are adequately addressed in sustainable development efforts, especially in environments that are known for excluding women from the conversation.

Efforts to address these challenges must consider the local context and involve community leaders in promoting gender-sensitive education and awareness programs. This can

help create a more supportive environment where women feel empowered to discuss and advocate for their rights without fear of repercussions.

3.3 GOAL 7 AFFORDABLE AND CLEAN ENERGY

Under Sustainable Development Goal 7 (SDG 7), clean energy is primarily defined by the use of renewable energy sources such as solar, wind, and hydropower, which generate electricity without emitting greenhouse gases during operation. Additionally, geothermal and biomass energy contribute to the clean energy mix by providing reliable energy with lower environmental impacts compared to fossil fuels. SDG 7 also emphasizes the importance of improving energy efficiency across various sectors, including industry, buildings, and transportation, to reduce energy consumption and lower greenhouse gas emissions. Furthermore, ensuring universal access to modern energy services is a critical component of SDG 7, which includes providing reliable and affordable electricity and clean cooking solutions to those who currently lack them (Sachs et al., 2023).

The students demonstrated a commendable understanding of the importance of the "Affordable and Clean Energy" goal, with both advanced and technical students assigning it high levels of importance, as evidenced by their mean scores. Advanced students rated this goal slightly higher at 3.87, while technical students rated it at 3.60 in Table 5. This suggests a shared recognition among students of the vital role affordable and clean energy plays in sustainable development efforts. Their acknowledgment aligns with global initiatives aimed at enhancing access to renewable energy sources while ensuring affordability and sustainability.

Interestingly, our study yielded contrasting findings compared to those outlined by Abowardah et al. (2024) Rather than demonstrating insufficient knowledge concerning sustainability aspects related to energy consumption and the use of renewable materials, both

groups of students exhibited a strong awareness and understanding in these areas. The results underscore the effectiveness of existing educational approaches in our institutions, which may include interdisciplinary coursework, experiential learning opportunities, and partnerships with industry stakeholders. These strategies have evidently succeeded in bridging knowledge gaps and equipping our students with the skills and knowledge needed for SRD.

The prioritization of the “Affordable and Clean Energy” goal by Brazilian students may be influenced by several factors. Brazil is known for its extensive use of renewable energy sources, particularly hydropower, which accounts for a significant portion of the country's electricity generation. The Itaipu Dam may be one of these factors.

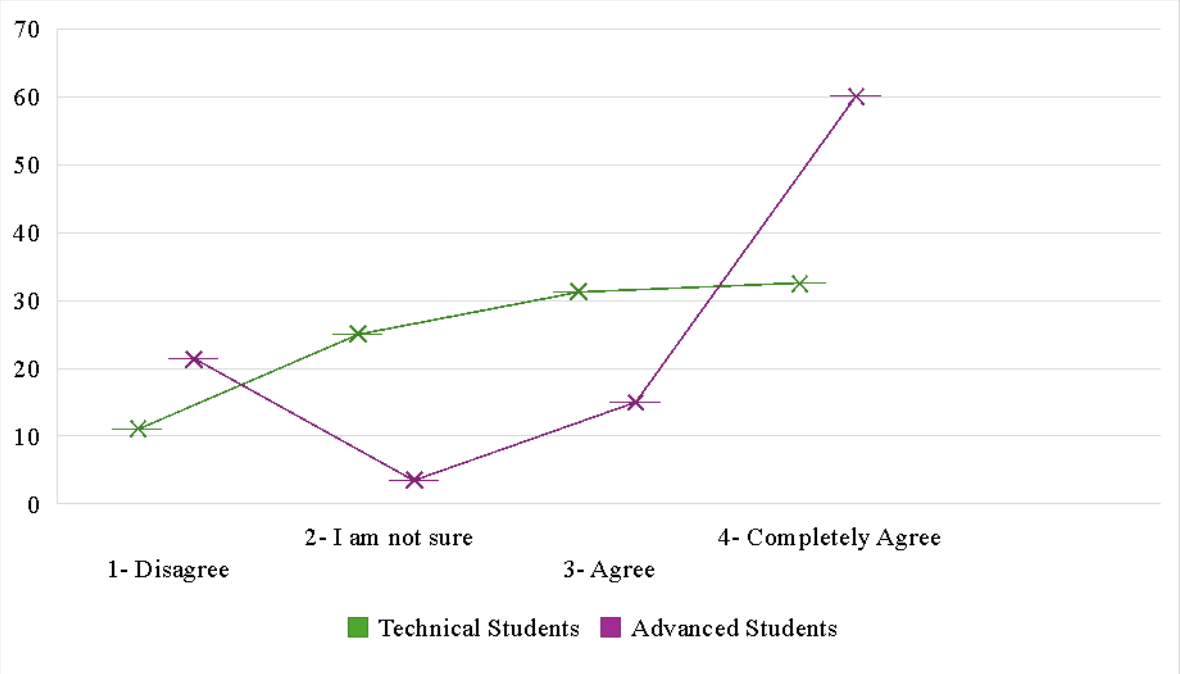
The Itaipu Dam, which is in this study geographical region, is the second largest hydroelectric power plant in the world. The Itaipu Dam is a significant landmark in renewable energy infrastructure. Situated on the Paraná River at the border between Brazil and Paraguay, the dam is a binational project managed by the Itaipu Binacional company and have several extension projects in the Paraná State region (Mello et al., 2021).

As a result, Brazilian students may have a heightened awareness of the importance of clean energy and its role in mitigating environmental impacts such as greenhouse gas emissions. Additionally, Brazil has made substantial investments in renewable energy infrastructure, including wind and solar power, which may contribute to a positive perception of clean energy among students (Jaiswal et al., 2017; Muhammed & Tekbiyik-Ersoy, 2020).

The emphasis on topics such as biofuel production, including the cultivation of crops for potential use as substitutes for fossil fuels, likely contributes to a greater awareness and appreciation of the importance of clean energy. By learning about the practical applications of renewable energy technologies and the potential of biofuels to reduce dependence on non-renewable resources, TVET students may develop a more favorable attitude towards sustainable energy practices, when compared to other high-school students.

To assess students' perceptions of clean energy, both cohorts were asked to rank on a scale from 1 to 4 how they consider hydroelectric and solar panels regarding their sustainability. The results, as shown in the graphs (Figure 8 and Figure 9), indicate that Technical Students' responses are more evenly distributed across the scale, with a significant portion agreeing or completely agreeing with the sustainability of these energy sources. In contrast, Advanced Students show a more polarized distribution, with the majority either agreeing or completely agreeing, but with a notable peak at “Completely Agree.” This suggests that Advanced Students have a stronger overall consensus on the sustainability of hydroelectric and solar panels compared to Technical Students.

Figure 8- The use of hydroelectric energy.



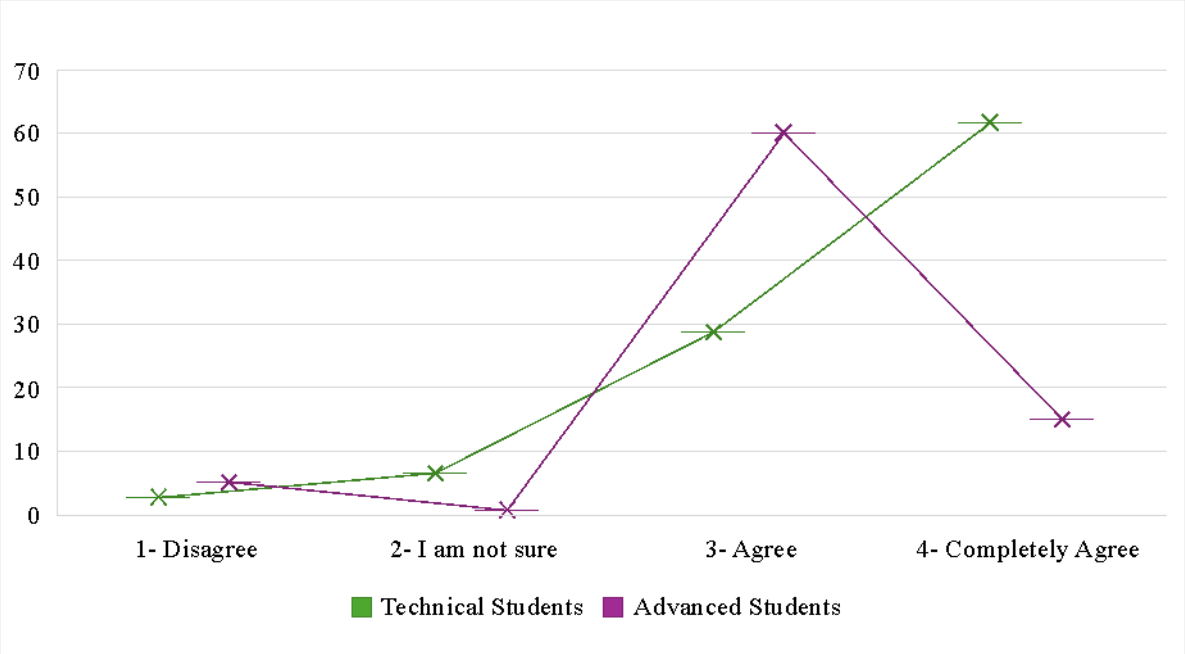
Source: The Authors (2024).

The sustainability of hydroelectric energy is a nuanced topic, and its evaluation depends on various factors, including environmental impact, social implications, and economic viability.

Hydroelectric energy is considered sustainable in terms of its low greenhouse gas emissions once operational. Unlike fossil fuels, hydroelectric plants do not emit significant amounts of CO2 during electricity generation. However, the construction of dams and reservoirs can lead to significant environmental disturbances, including habitat destruction, changes in water quality, and impacts on local biodiversity. For example, large reservoirs can produce methane, a potent greenhouse gas, particularly in tropical regions due to the decomposition of organic matter underwater (Berga, 2016; McNally et al., 2009; Samiotis et al., 2018)

Additionally, hands-on experiences, such as fieldwork or laboratory experiments related to biofuel production, may further enhance students' understanding and enthusiasm for clean energy solutions. Overall, the integration of relevant subjects into the technical education curriculum plays a crucial role in shaping students' perceptions and attitudes towards sustainable development goals, including clean energy initiatives.

Figure 9- The use of solar panels.



Source: The Authors (2024).

Solar power is generally considered a sustainable energy source due to its low operational emissions, decreasing costs, and potential for technological advancements. However, addressing the environmental impacts associated with material use and land requirements, as well as improving energy storage solutions, is crucial for maximizing its sustainability. Continued research, policy support, and technological innovation will play key roles in ensuring that solar power contributes effectively to a sustainable energy future (Lazaroiu et al., 2023; Maka & Alabid, 2022).

The data is consistent to the findings of Zsóka et al. (2013), according to them, students who exhibit greater dedication to environmental education typically possess a more profound comprehension of environmental matters and principles. The emphasis placed on environmental education significantly influences students' perspectives on sustainable consumption and lifestyle decisions. Through covering subjects concerning consumerism and sustainable behaviors, environmental education can enhance students' understanding of the necessity for altering consumption habits.

By providing opportunities for students to apply sustainability principles in their daily lives and engage in meaningful sustainability projects, institutions can empower students to become change agents for sustainability within their communities. This finding aligns with the perspectives of other scholars, such as Akçay et al. (2024), who emphasize the pivotal role of education in promoting global citizenship and sustainable development. The authors also advocate for the integration of SDGs into higher education curricula as a means to cultivate awareness and empower students to take action. This approach underscores the critical role of higher education institutions in championing SDGs among students through various strategies, with curriculum integration serving as a fundamental component. By embedding SDGs into academic coursework across diverse disciplines, institutions can effectively educate students

about the significance of the goals and their individual responsibilities in contributing to their achievement.

This observation is consistent with Aslam et al. (2022) who see a growing recognition of SD as a critical component of higher education in the post-pandemic era and the importance of fostering sustainable practices and behaviors among students to drive positive change towards a more sustainable future. Overall, these findings resonate with those of Abowardah et al. (2024), particularly regarding the prioritization of environmental conservation over social sustainability by the majority of students. This preference holds significant implications for sustainability initiatives and policies within higher education institutions and society at large.

The emphasis on environmental issues may lead to an imbalance in resource allocation and attention, potentially overshadowing the importance of addressing social aspects of sustainability, such as equity and justice. As a result, there is a critical need to reevaluate current approaches and ensure a more holistic understanding and integration of both environmental and social dimensions of sustainability in educational curricula and institutional policies.

Furthermore, the implementation of sustainability initiatives on campus, such as energy conservation, green agriculture, waste reduction, and recycling programs, is highlighted as a means of showcasing the practical applications of SDGs and promoting sustainable behaviors among students. Additionally, organizing awareness campaigns, workshops, seminars, and events dedicated to SDGs plays a crucial role in educating students, faculty, and staff about the goals' importance and ways to contribute to their achievement (Reimers, 2021).

By fostering a more balanced perspective and addressing the interconnectedness of environmental and social challenges, education institutions can better prepare students to contribute meaningfully to sustainable development efforts in their communities and beyond. Nonetheless, further analysis is warranted to delve into the specific factors driving their

prioritization of this goal and to pinpoint areas for potential enhancement in promoting sustainable energy practices among students.

3.4 CORRELATION ANALYZES

To find the relationships between the variables, the data was submitted to a correlation analyses. The correlation matrix not only illuminates the presence of relationships but also delineates their strength and direction. Whether variables exhibit positive, negative, or no discernible correlations, the matrix offers a comprehensive overview, and enables nuanced associations crucial for hypothesis testing and predictive modeling endeavors.

Since R-studio has excellent support for statistical analysis, we built a correlation matrix using the R programming language, for that with the aid of the package stats, a correlation matrix (appendix 3 and 4) was developed. Each value in the matrix represents the strength and direction of the linear relationship between pairs of variables, ranging from -1 to 1, reflecting TVET students' perceptions of the importance of sustainable development goals for general welfare (Figure 10).

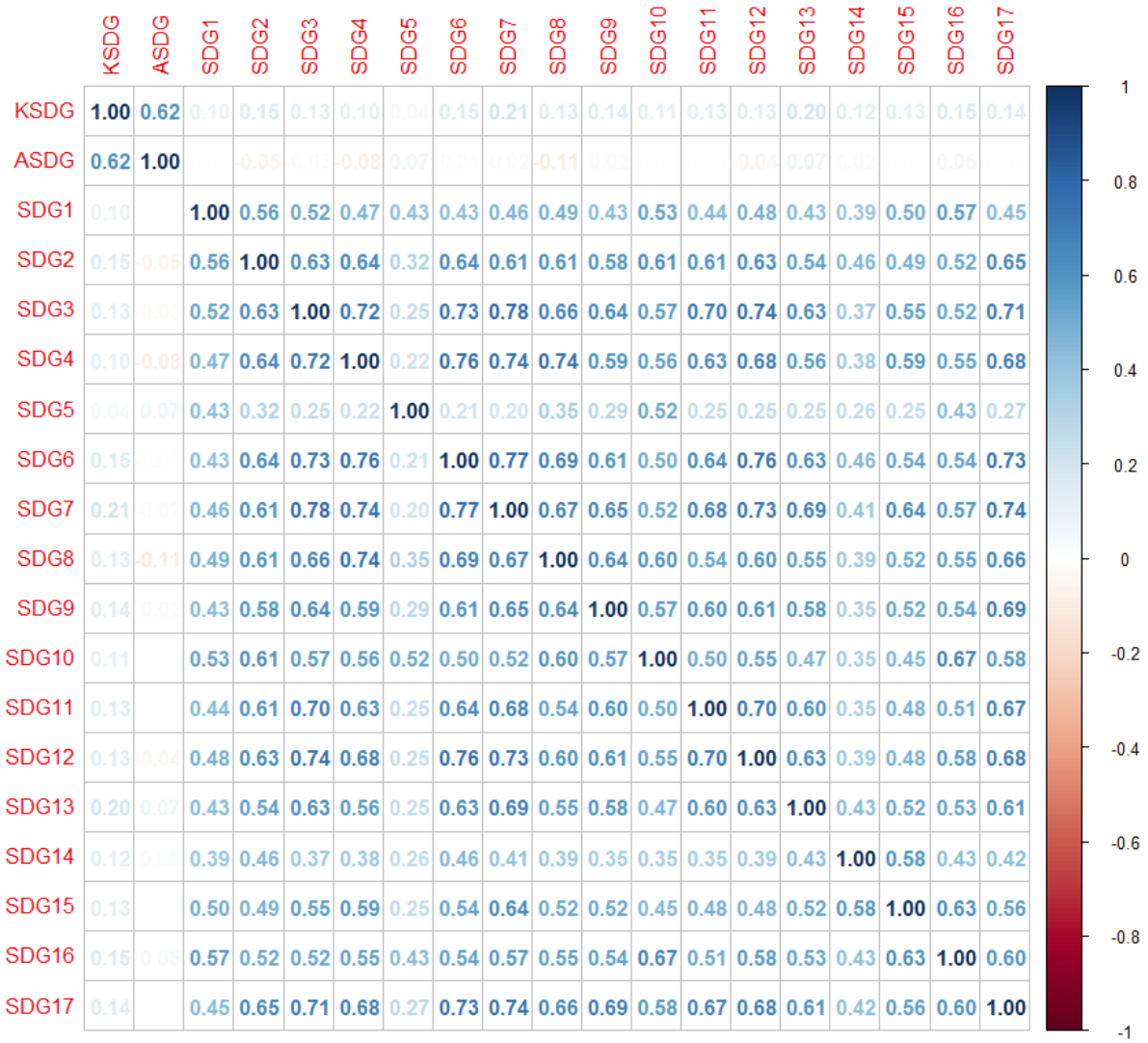
The strong and moderate correlations among the SDGs emphasize their interconnectedness, meaning that progress in one area often supports progress in others. This interconnectedness creates a synergistic effect, enhancing overall sustainable development. For example, improvements in Zero Hunger (SDG2) are closely linked with advancements in Good Health and Well-being (SDG3), Quality Education (SDG4), Clean Water and Sanitation (SDG6), and Affordable and Clean Energy (SDG7). Addressing these interconnected goals holistically can lead to more efficient and impactful outcomes.

To enhance specific SDGs, focusing on related areas is essential. Improving Health (SDG3): Requires advancements in Quality Education (SDG4), Clean Water and Sanitation

(SDG6), and Affordable and Clean Energy (SDG7). Ensuring that education facilities have access to clean water and energy, and integrating health education into school curricula can significantly boost health outcomes.

According to the interviewed TVET students, advancing Quality Education (SDG4) is linked to Clean Water and Sanitation (SDG6), Affordable and Clean Energy (SDG7), and Decent Work and Economic Growth (SDG8). Providing clean water and sanitation in schools, reliable energy supply, and aligning educational programs with labor market needs can improve both educational and economic outcomes.

Figure 10-Heatmap of correlations among TVET agrarian students.



Source: The Authors (2024).

Emphasizing the interconnections between SDGs in educational curricula fosters a more integrated approach to sustainability education. Teaching students about these relationships helps them understand the comprehensive nature of sustainable development and prepares them to contribute effectively to sustainability efforts. This approach can include practical examples and case studies that demonstrate how achieving one SDG can positively influence others.

In relation to Effective partnerships (SDG17), TVET students agreed that they are crucial for achieving many other SDGs, such as Clean Energy (SDG7). Collaborative efforts can mobilize resources, foster innovation, and improve infrastructure and policy frameworks. Partnerships can help secure financial and technical resources necessary for implementing clean energy projects, including funding, technology transfer, and expertise sharing. Collaborative efforts bring diverse perspectives and expertise, driving the development of new technologies and approaches that enhance sustainability.

Improving Infrastructure and Policy Frameworks Partnerships can advocate for policies promoting renewable energy adoption and improving energy access, creating a supportive environment for sustainable practices. These resources can provide deeper insights into the interconnectedness of the SDGs and strategies for integrating them into education and policymaking.

The data aligns with the work of Dörgo et al. (2018), who identified complex cause-and-effect relationships between the SDGs using Granger causality analysis. Their study underscores the strong interconnectedness of sustainability targets and the relevance of causal loop networks for policy-making.

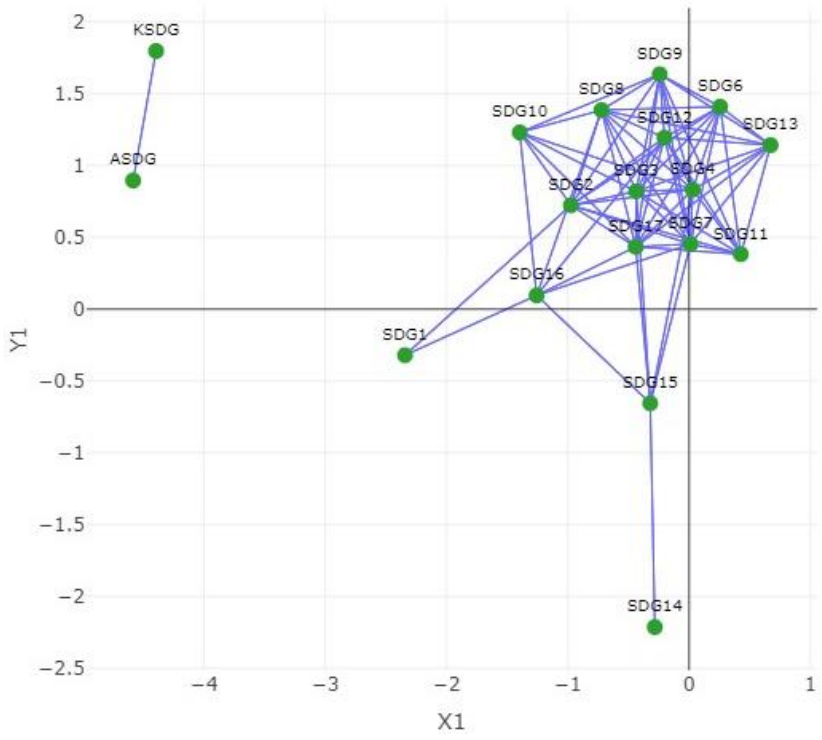
Similarly, the TVET students' responses resonate with the framework presented by Kioupi & Voulvoulis (2019) which integrates SDGs into educational outcomes through systems

thinking. This framework highlights the pivotal role of education in achieving sustainability and developing the necessary competences for transformative learning.

Furthermore, the data aligns with the discussions by Breuer et al. (2019) who advocate for translating SDG interdependencies into coherent policy actions. Their work emphasizes the importance of systematic and integrated approaches to policymaking for sustainable development.

These alignments suggest that the observed data not only supports existing theoretical frameworks but also provides practical insights into how educational and policy strategies can be developed to achieve the SDGs. Each green dot represents a variable, and each line represents the connection between variables as depicted in the correlation matrix for TVET students (Figure 11).

Figure 11- Network graph of correlations among TVET agrarian students.



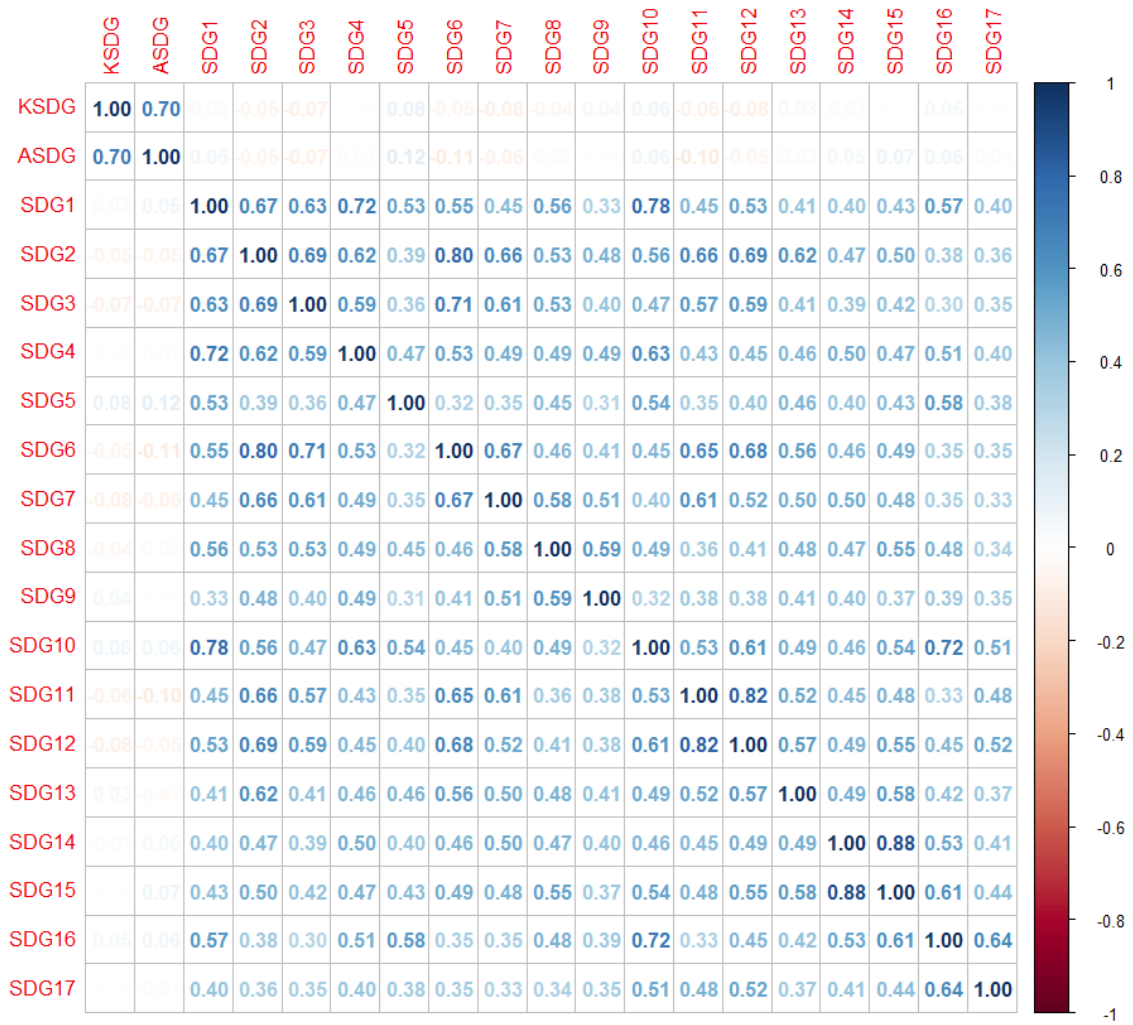
Source: The Authors (2024).

Each value in the matrix represents the strength and direction of the linear relationship between pairs of variables, ranging from -1 to 1, reflecting advanced students' perceptions of the importance of sustainable development goals for general welfare (Figure 12).

The provided data, representing the correlation coefficients between various Sustainable Development Goals (SDGs) and indices such as Knowledge of SDGs (KSDG) and Awareness of SDGs (ASDG), underscores the interconnected nature of these goals and highlights the critical role of education and awareness in advancing sustainable development.

The high correlation between KSDG and ASDG (0.7013) indicates that enhancing knowledge about SDGs directly increases awareness of these goals. This relationship is crucial for fostering a comprehensive understanding of sustainability issues among students and the broader community. By integrating SDG education into curricula, educational institutions can significantly impact both knowledge and awareness, thereby promoting sustainable practices.

Figure 12-Heatmap of correlations among advanced students.



Source: The Authors (2024).

According to Collste et al. (2017), coherently addressing the SDGs requires integrated simulation models to assess effective policies and recognize the systemic interdependencies among goals. The interconnectedness among various SDGs, such as the strong positive correlations between SDG1 (No Poverty) with SDG2 (Zero Hunger), SDG3 (Good Health and Well-being), and SDG4 (Quality Education), emphasizes the importance of integrated approaches. For instance, reducing poverty can have a cascading positive effect on hunger

reduction, health improvements, and educational advancements. This holistic view aligns with the findings from recent studies that advocate multidimensional and integrated strategies to achieve the SDGs effectively.

Educational programs that enhance knowledge (KSDG) and awareness (ASDG) about SDGs are instrumental in driving sustainable development. As advanced students in rural development gain a deeper understanding of SDGs, they are better equipped to implement these goals in their professional and community engagements. Incorporating SDG education into curricula not only informs but also empowers students to adopt sustainable practices and advocate for comprehensive policy changes.

For example, understanding the significant correlations between SDG2 (Zero Hunger) and other goals like SDG3 (Health) and SDG6 (Clean Water) can help students and future policymakers design integrated programs that address multiple goals simultaneously. This approach is crucial for creating sustainable and resilient communities (Collste et al., 2017)

Advanced students' understanding of the interdependencies among SDGs can significantly influence policymaking and community engagement. Knowledgeable and aware policymakers are more likely to create effective, holistic policies that support sustainable development across various sectors. For instance, recognizing the strong link between SDG11 (Sustainable Cities) and SDG12 (Responsible Consumption) can guide urban planners to integrate sustainable consumption practices into city planning, enhancing urban sustainability (Biermann et al., 2022).

Community outreach programs that raise awareness and educate the public about SDGs can lead to increased community engagement in sustainable practices. When community members understand the importance of SDGs, they are more likely to adopt sustainable behaviors and support local initiatives. This grassroots engagement is vital for achieving long-term sustainability goals (Allen et al., 2019).

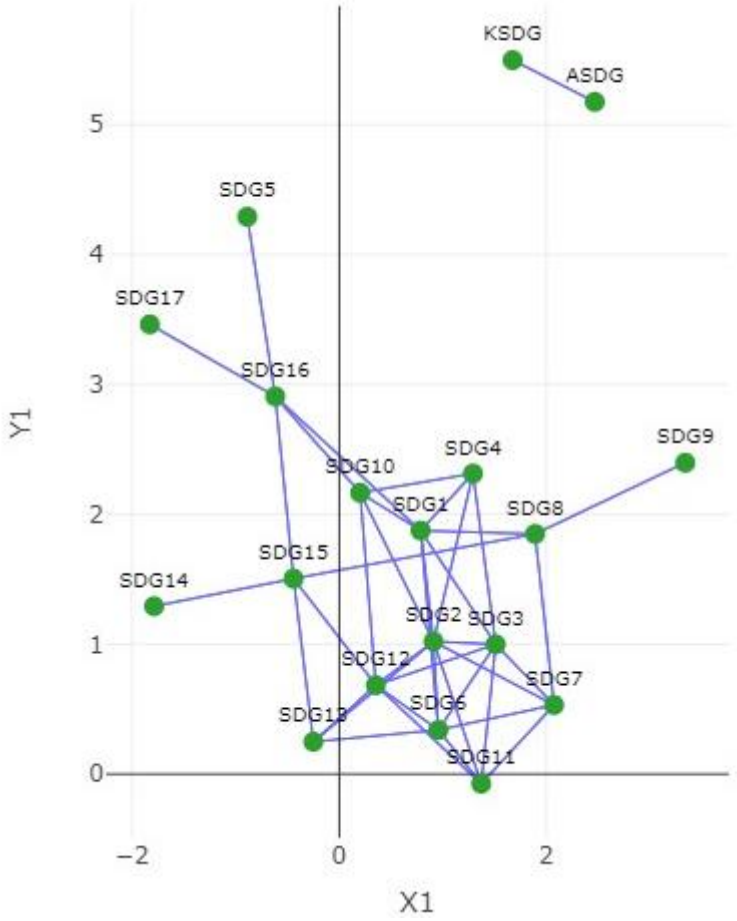
The strong correlations between SDGs highlight the need for integrated policy frameworks that consider interdependence among goals. Policymakers should adopt cross-sectoral approaches that address multiple goals simultaneously. For instance, policies that promote clean water and sanitation (SDG6) should also consider their impact on health (SDG3) and education (SDG4).

Effective partnerships (SDG17) are crucial in this context. Collaborative efforts can mobilize resources, foster innovation, and create supportive infrastructure and policy environments. Partnerships between educational institutions, governments, NGOs, and the private sector can facilitate the sharing of knowledge, technology, and resources necessary for sustainable development (Biermann et al., 2022).

The understanding of SDGs among advanced students in rural development programs is critical for the successful implementation of these goals. Their knowledge and awareness can drive effective educational programs, informed policy-making, and active community engagement. By emphasizing the interconnectedness of SDGs and adopting integrated approaches, educational institutions and policymakers can significantly enhance sustainable development efforts. This holistic approach is essential for addressing the complex challenges of sustainability and achieving the comprehensive and transformative change envisioned by the SDGs.

Each green dot represents a variable, and each line represents the connection between variables as depicted in the correlation matrix for advanced students (Figure 13).

Figure 13- Network graph of correlations among advanced students.



Source: The Authors (2024).

4- CONCLUSIONS

This study provides valuable insights into the perceptions of students, particularly those in agricultural and rural education, regarding Sustainable Development Goals (SDGs). The findings highlight the significance of integrating environmental education initiatives into educational curricula to cultivate awareness, empower students, and promote sustainable practices. By incorporating topics related to consumerism and sustainable behaviors, environmental education can deepen students' understanding of the need to change consumption

patterns, particularly concerning nonrenewable resources like fossil fuels and chemical fertilizers.

The strong and moderate correlations among the SDGs emphasize their interconnectedness, meaning that progress in one area often supports progress in others. This interconnectedness creates a synergistic effect, enhancing overall sustainable development. For example, improvements in Zero Hunger (SDG2) are closely linked with advancements in Good Health and Well-being (SDG3), Quality Education (SDG4), Clean Water and Sanitation (SDG6), and Affordable and Clean Energy (SDG7). Addressing these interconnected goals holistically can lead to more efficient and impactful outcomes.

Furthermore, the study underscores the pivotal role of education in advancing sustainable development and advocates for holistic approaches to sustainability education that address environmental, social, and economic dimensions. By embracing these comprehensive educational strategies, we can better prepare students to become active contributors to a more sustainable and resilient future.

Integrate SDG education into the curricula of educational institutions, particularly in rural development and technical programs. This integration should emphasize the interconnections between SDGs and include practical examples and case studies that demonstrate how achieving one SDG can positively influence others.

Provide targeted training programs for educators to equip them with the necessary knowledge and skills to effectively integrate SDGs into their teaching practices. By aligning educational content with the interests and concerns of future educators, institutions can ensure that they are adequately prepared to engage their students in meaningful discussions and activities related to sustainable development.

It is evident from the study that both student cohorts demonstrate a strong emphasis on certain SDGs, particularly those related to agriculture and clean energy, especially in terrestrial

environments. However, there are notable gaps in knowledge and understanding, particularly concerning the social and economic dimensions of sustainability. Acknowledging and addressing these differences in SDG perspectives between the two cohorts is essential for developing more inclusive and effective sustainable development education programs. This approach ensures that future teachers are equipped to instill environmental stewardship and social responsibility in their students, while agrarian technicians can lead sustainable development efforts within their communities.

The study's advocacy for curriculum revision to encompass the entirety of sustainability reflects the critical need for holistic sustainability education. By integrating environmental, social, and economic dimensions into curricula, educational institutions can offer students a comprehensive understanding of sustainability issues. This approach equips students with tools to tackle the complex challenges of sustainability and make meaningful contributions to sustainable development in diverse sectors. Moreover, embracing holistic education fosters a profound recognition of the interconnectedness of environmental, social, and economic systems among students, empowering them to effect transformative changes in their professional endeavors.

Drawing from the insights of this research, educators and policymakers can enhance environmental education initiatives and raise awareness about sustainability issues. By empowering future professionals with the knowledge and skills to adopt eco-friendly behaviors, we can pave the way for a cleaner and more sustainable future.

As we move forward, it is imperative to continue building on these findings and implementing strategies to promote sustainability education and action among students, ensuring a more sustainable and resilient future for all. Furthermore, future research should focus on discerning disparities between rural and urban settings, particularly exploring the factors that influence students' decision-making processes. Understanding these factors will

provide a more nuanced approach to education and policy development, ensuring that sustainability efforts are effectively tailored to the needs of diverse communities.

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ARTICLE 3- HARVESTING INSIGHTS: AGRARIAN TECHNICIANS AND ADVANCED STUDENTS DELVE INTO AGRICULTURE AND CLIMATE CHANGE IN BRAZIL

ABSTRACT

This study explores the perceptions and knowledge of advanced and agrarian technicians' students in Brazil regarding climate change and its implications for agriculture. By focusing on two distinct groups (242 high school students enrolled in an integrated agricultural technician course and 248 master's and doctoral students specializing in rural development) we aim to uncover how future professionals perceive and respond to the challenges posed by climate change. The research employs a comprehensive mixed-methods approach, utilizing surveys with Likert scale questions and open-ended responses to assess students' understanding of climate change, the feasibility of reducing emissions without compromising production, and the potential for increasing agricultural profits while preserving the environment. The results highlight a strong consensus among students on the reality and significance of climate change, with a majority recognizing the substantial impact of unsustainable agricultural practices and the necessity for adopting sustainable measures. Key findings reveal a generally optimistic outlook on the potential for sustainable agricultural practices to mitigate climate change, supported by technological advancements and effective policy measures. However, the presence of neutral responses indicates areas where further education and dissemination of successful case studies are needed. The study also identifies common misconceptions and knowledge gaps, emphasizing the importance of tailored educational initiatives to enhance climate literacy and promote sustainable agricultural practices. The insights gained from this analysis underscore the critical role of education in shaping future professionals' approaches to climate change mitigation. By integrating climate change topics into agrarian curricula and

promoting experiential learning opportunities, educational institutions can empower students to engage in climate action and advocate for sustainable practices. The study concludes by highlighting the need for continued research and targeted interventions to address sector-specific perceptions and enhance the resilience of agricultural systems in the face of climate change. These efforts are essential for fostering a sustainable and resilient agricultural sector that balances economic growth with environmental stewardship and an equitable society.

Keywords: Climate Change Mitigation; Sustainable Agriculture; Agrarian Education; Environmental Literacy; Agricultural Resilience.

ARTIGO 3- COLHENDO INSIGHTS: TÉCNICOS AGRÁRIOS E ESTUDANTES AVANÇADOS EXPLORAM A AGRICULTURA E AS MUDANÇAS CLIMÁTICAS NO BRASIL

RESUMO

Este estudo explora as percepções e conhecimentos de estudantes avançados e técnicos agrícolas no Brasil sobre as mudanças climáticas e suas implicações para a agricultura. Focando em dois grupos distintos (242 estudantes do ensino médio matriculados em um curso técnico agrícola integrado e 248 estudantes de mestrado e doutorado especializados em desenvolvimento rural), buscamos descobrir como os futuros profissionais percebem e respondem aos desafios impostos pelas mudanças climáticas. A pesquisa emprega uma abordagem abrangente de métodos mistos, utilizando questionários com perguntas em escala Likert e respostas abertas para avaliar a compreensão dos estudantes sobre as mudanças climáticas, a viabilidade de reduzir as emissões sem comprometer a produção e o potencial de aumentar os lucros agrícolas preservando o meio ambiente. Os resultados destacam um forte consenso entre os estudantes sobre a realidade e a importância das mudanças climáticas, com a maioria reconhecendo o impacto substancial das práticas agrícolas insustentáveis e a necessidade de adotar medidas sustentáveis. As principais conclusões revelam uma perspectiva geralmente otimista sobre o potencial das práticas agrícolas sustentáveis para mitigar as mudanças climáticas, apoiadas por avanços tecnológicos e medidas políticas eficazes. No entanto, a presença de respostas neutras indica áreas onde são necessárias mais educação e disseminação de estudos de caso bem-sucedidos. O estudo também identifica concepções errôneas comuns e lacunas de conhecimento, enfatizando a importância de iniciativas educacionais personalizadas para melhorar a alfabetização climática e promover práticas agrícolas sustentáveis. Os insights obtidos desta análise ressaltam o papel crítico da educação na formação das abordagens dos futuros profissionais para a mitigação das mudanças

climáticas. Ao integrar tópicos de mudanças climáticas nos currículos de ambos os grupos e promover oportunidades de aprendizado experiencial, as instituições educacionais podem capacitar os estudantes a se envolverem em ações climáticas e defender práticas sustentáveis. O estudo destaca a necessidade de pesquisas contínuas e intervenções direcionadas para abordar percepções específicas do setor e aumentar a resiliência dos sistemas agrícolas diante das mudanças climáticas. Esses esforços são essenciais para fomentar um setor agrícola sustentável e resiliente que equilibre o crescimento econômico com a administração ambiental e uma sociedade equitativa.

Palavras-chave: Mitigação das Mudanças Climáticas; Agricultura Sustentável; Educação Agrária; Alfabetização Ambiental; Resiliência Agrícola.

1- INTRODUCTION

In the intricate tapestry of global challenges, few issues loom as ominously as climate change. Its tendrils reach into every aspect of human existence, shaping landscapes, economies, and societies (Chien et al., 2023; do Nascimento Bento et al., 2023; Leal Filho et al., 2023; Subramanian et al., 2023). Within the context of agriculture, a sector profoundly influenced by climatic conditions, the impacts of climate change reverberate with particular resonance. Understanding how those at the forefront of agrarian knowledge perceive and respond to climate change is essential for crafting effective strategies to mitigate its effects and foster resilience in agricultural systems.

For that reason, we define climate change as a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2022a).

Many studies around the world have documented the effects of climate change on agriculture, Zhang et al. (2022) evaluating the long-term effects of climate change on wheat production in China's top three wheat-producing provinces: Hebei and Henan revealed that climatic factors like temperature and rainfall had varying impacts across these regions. In Henan, climate change negatively influenced wheat production, while in Hebei, it contributed positively.

A study conducted in West Africa by Wood & Mendelsohn (2015) assessed the impact of climate change on agricultural net revenue. The study used cross-sectional analysis to demonstrate how climate variables such as temperature and precipitation changes affected

agricultural productivity. It emphasized the economic vulnerabilities of smallholder farmers to climate variability and the need for adaptive strategies to mitigate adverse effects.

Zúñiga et al. (2021) in a case study in Chile explored how small-scale farmers adapted to droughts. The authors found that climate change, particularly increased frequency and severity of droughts, significantly impacted crop yields. Farmers adapted by changing crop types, altering planting dates, and investing in irrigation systems to cope with reduced water availability

In Brazil, de Matos Carlos et al. (2020), studied agricultural vulnerability to climate change in the Northeast region, describing how variations in climate, such as changes in rainfall patterns and temperature affect agricultural productivity. The study suggested that climate change exacerbates existing vulnerabilities, necessitating the implementation of adaptive measures to ensure sustainable agricultural practices.

The urgency of embracing sustainable agriculture is underscored by the interconnected crises that confront humanity today. Climate change, driven primarily by human activities such as deforestation and the burning of fossil fuels (IPCC, 2022a), threatens to disrupt weather patterns, degrade soil quality, and exacerbate extreme weather events all of which pose significant risks to agricultural productivity (Yohannes, 2016). Furthermore, the unsustainable use of natural resources (Feng et al., 2023), including water and arable land, places immense strain on ecosystems and compromises their ability to support future food production.

Agriculture is an essential sector in Brazil, which, along with exports, is one of the sectors that most significantly impacts the Gross Domestic Product (GDP), constituting about 20% of the country's economic structure (Sobreira et al., 2018).

In the subject of agriculture, the state of Paraná (southern region of Brazil) holds significant agricultural importance, playing a crucial role in the production of various agricultural goods. The stathe of Paraná is one of Brazil's largest grain producers. In 2023, the

state produced approximately 36 million tons of soybeans and corn combined, accounting for about 16% of the national production of these grains (IPARDES, 2023).

The state of Paraná also excels in livestock production, especially in pork and poultry. In 2023, the state produced about 2.3 million tons of chicken meat, accounting for approximately 33% of the national production. The state also was responsible for around 1 million tons of pork in 2023, making it one of the top meat producers in Brazil, in which the municipality of Toledo stands out, as the biggest producer of swine in the country (IPARDES, 2023).

Assunção & Chein (2016) used IPCC projections to simulate the effects of climate change on agricultural productivity across Brazilian municipalities. The study predicts an average temperature increase of 1.43°C and a 1.44% reduction in rainfall from 2030 to 2049, which is expected to decrease agricultural output per hectare by approximately 18%. The impacts will be highly heterogeneous, with some regions experiencing productivity losses of up to 40%, while others might see slight gains of up to 15%. Notably, the northern and northeastern regions, which are more vulnerable, are expected to suffer the most, while the southern region might benefit due to longer growing seasons and favorable rainfall increases.

On the other hand, excessive rainfall can lead to soil erosion, washing away the fertile topsoil essential for crop growth. This degradation reduces soil quality and fertility, diminishing agricultural productivity over time. Additionally, heavy rainfall can cause waterlogging in fields, particularly in areas with poor drainage systems. Waterlogged soil suffocates plant roots by reducing oxygen availability, leading to root decay and negatively impacting crop health and yields. Higher moisture levels from increased rainfall create favorable conditions for the proliferation of pests and plant diseases, resulting in higher incidences of fungal infections and other diseases that thrive in wet environments, thereby damaging crops and reducing yields. Furthermore, heavy rainfall can damage agricultural infrastructure, such as irrigation systems,

roads, and storage facilities. This disrupts even the supply chain, making it difficult to transport goods to market, increasing post-harvest losses. These challenges necessitate the implementation of effective water management practices and infrastructure improvements to mitigate the adverse effects of increased rainfall in southern Brazil (Peterson et al., 2020).

Peterson et al. (2020), examining the resilience of integrated crop-livestock systems to climate change in southern Brazil using APSIM software simulation analysis, suggests that integrated systems with cover crops and grazing can enhance resilience by improving soil moisture retention and overall productivity, thereby mitigating some adverse effects of climate change.

Rural communities heavily rely on natural resources for their livelihoods, making them more vulnerable to climate-related risks such as extreme weather events, changes in precipitation patterns, and rising temperatures (Bendiksen, 2010; IPCC, 2007; World Meteorological Organization, 2023a, 2023b, 2024). Additionally, agricultural practices in rural areas can contribute to greenhouse gas emissions, further exacerbating climate change (IPCC, 2022b; MCTIC, 2013, 2021b, 2021a, 2022; UN, 2021, 2023). Therefore, addressing climate change is crucial for achieving various Sustainable Development Goals (SDGs) related to poverty eradication, food security, health, and environmental sustainability, especially in rural settings where the impacts are most pronounced.

The SDGs serve as a comprehensive framework for addressing global challenges, with climate change standing out as a pivotal issue interconnected with many of these goals. Particularly in rural areas, the impacts of climate change are acutely felt, as they are often both victims and contributors to environmental degradation.

Addressing the perceptions of advanced students of rural development and agrarian TVET in Brazil regarding the effects of agriculture on climate change is a critical knowledge gap that warrants investigation. Brazil's economy and societal fabric are heavily intertwined

with rural activities (Abrehe et al., 2022; Nunes De Castro, 2014; OECD, 2015; Valdes et al., 2016; Vianna et al., 2020), making it imperative to understand how future agricultural professionals perceive and interpret the complex interactions between agriculture and climate change. Through their hands-on experience and academic endeavors, these individuals offer valuable insights into the complex interplay between agriculture and climate change in one of the world's most agriculturally rich nations.

Existing literature predominantly focuses on farmers' perspectives on climate change, (Adimassu & Kessler, 2016; Gasson et al., 1998; Gori Maia et al., 2018; Hyland et al., 2016; Litre & Bursztyn, 2015; Mumtaz et al., 2019; Ricart et al., 2019; Salman et al., 2018), Research on students' perceptions of climate change reveals significant insights into their understanding and attitudes towards this global issue. A study conducted at the University of the South Pacific in Fiji found that most students (94%) believe in the reality of climate change, emphasizing the role of education in enhancing climate awareness and fostering proactive measures among youth (Prasad & Mkumbachi, 2021). Similarly, research on Ghanaian undergraduate students showed that 97.9% acknowledged climate change as real and attributed it to human activities, with perceptions influenced by educational background and year of study (Ofori et al., 2023). Additionally, a study examining the awareness and perceptions of students and teachers regarding low carbon eco-friendly practices highlighted the need for integrating climate change topics into educational curricula to promote sustainable practices and enhance climate literacy (Natalia et al., 2023). However, no studies were found connecting the insights that advanced students of rural development and agrarian Technical Vocational Education and Training (TVET) students can offer. These students represent the next generation of agricultural leaders and policymakers who will shape the future of Brazil's agricultural landscape. Investigating their perceptions is crucial, as they will influence farming practices, policy decisions, and agricultural innovations in the years to come.

Moreover, advanced students are expected to bring fresh perspectives and innovative ideas, informed by their academic training and exposure to cutting-edge research. Their insights can provide valuable contributions to understanding the nuanced dynamics between agriculture and climate change, offering new avenues for adaptation and mitigation strategies.

By bridging this knowledge gap and exploring the perceptions students, we can gain a deeper understanding of how agriculture is perceived within the context of climate change in Brazil. This understanding can inform educational initiatives, policy development, and research agendas, ultimately fostering more sustainable and resilient agricultural practices in Brazil and beyond.

In synthesizing the diverse perspectives of agrarian technicians and advanced students, we aspire to catalyze informed dialogue and action on climate change adaptation and mitigation within the agricultural sector. By amplifying their voices and insights, we strive to foster a deeper appreciation of the interconnectedness between agriculture, climate change, and human well-being.

Furthermore, by juxtaposing the viewpoints of agrarian technicians and emerging scholars, we seek to elucidate the evolving narrative surrounding climate change within agricultural communities. How do these individuals perceive the drivers of climate change, such as greenhouse gas emissions and deforestation? What are their thoughts on the effectiveness of current mitigation measures, from crop diversification to soil conservation practices?

That said, in this article we aim to uncover the multifaceted perspectives and expertise of agrarian technicians and advanced students in Brazil. As we delve deeper into their knowledge and experiences, we aim to illuminate the challenges, opportunities, and innovative solutions shaping the future of Brazilian agriculture amidst the evolving climate landscape.

2- METHODOLOGY

For this article, two groups of students from Brazil were selected. The first group consisted of 242 high school students enrolled in an integrated agricultural technician course in the second and third grades at the State Agricultural College of Toledo (CAET), while the second group comprised 248 master's and doctoral students focusing on rural development.

The cohort selection was based on the perception that in Brazil, most advanced students become teachers, and the way teachers understand and consider climate change issues is reflected in how future generations will understand and consider these issues. As a result, when discussing climate change, it is crucial to consider the perspectives of these future educators. When talking about TVET agrarian students, we recognize that these students could be responsible for implementing many climate-resilient agricultural practices in their field of work, making them essential for the sustainability and resilience of the agricultural sector in the face of climate change.

The State Agricultural College of Toledo (CAET) was selected for this study due to its prominent role in agricultural education in the region of Toledo, Paraná, in the southern region of Brazil. As a specialized institution focusing on TVET agricultural sciences and technologies, CAET offers a curriculum that integrates both theoretical knowledge and practical skills in agrarian studies. The college provides an ideal setting for studying climate change impacts on agriculture due to its emphasis on practical learning experiences and its commitment to environmental stewardship.

Additionally, the geographical location of CAET in Toledo, a region known for its agricultural production, provides a relevant context for exploring the relationship between education and climate-resilient rural development. Studying at CAET allows for insights into

how agricultural education can contribute to the adoption of climate-resilient practices and sustainable rural development in the context of Paraná.

Survey design and procedures.

After completing the documentary research for article 01, we developed a comprehensive questionnaire with open-ended, descriptive, and multiple-choice questions, using the Google Forms platform.

The main purpose of this form was to obtain a deep understanding of students' perceptions regarding sustainable agriculture, sustainability, and their views on the importance of the sustainable development goals for general welfare, based on the studies of (Akçay et al., 2024; Chankseliani & McCowan, 2021; Ho et al., 2022; Jones et al., 2024; Kleespies & Dierkes, 2022; Koçulu & Topçu, 2024; Lei & Tang, 2023; Ohta et al., 2022; UN, 2022; Yuan et al., 2021). Through these questions, we aimed to capture the perspectives and knowledge of the students on these topics to enrich our analysis and contribute to a more comprehensive view of issues related to the approaches of the SDGs by schools.

Data collection and sample.

For that, two distinct questionnaires were developed, one for Advanced Students and another for TVET students, tailored to the specific context and language of each group. The questionnaires can be found in the appendix section and were used in article 02 and article 03 as well.

As mentioned in the previous article, the questionnaire was administered to advanced students using the online survey platform, Google Forms, to facilitate data collection and analysis. Advanced students received their questionnaire via email and completed it during scheduled class sessions. To ensure the quality of responses and clarify any doubts, clear

guidelines were provided. Participation was voluntary, and data was collected over a two-week period.

A sample of 248 advanced students was obtained. Of the students surveyed, 143 (57,6%) are female and 105 (42,4%) males. The age of respondents varies between 22 and 64, but the highest response rate was in the 26 range. Most respondents were pursuing their master's degree 128 (51.61%) and 120 (48.39%) their doctorate degrees.

Throughout the study, utmost care was taken to uphold ethical standards. Informed consent was diligently obtained from all participants, with assurances of anonymity, confidentiality, and secure data storage for research purposes. For TVET cohort, structured questionnaires with open and closed-ended questions, using the Likert-type scale (DeVellis, 2016; Jamieson, 2005), were administered through the Google Forms tool, a detailed and objective tool for assessments (Komperda, 2017). The data obtained was organized on the platform itself using the online spreadsheet program. Subsequently, with the assistance of R-Studio (R-studio, 2022), the data underwent descriptive analysis (Komperda, 2017).

A sample of 242 TVET agrarian students was obtained. Of the students surveyed, 132 (54.3%) are male and 106 (43.6%) female, and 5 (2.1%) were gender non-specific. The age of respondents varies between 15 and 17, but the highest response rate was in the 16 range. Most respondents were in the second grade 125 (51.7%) and 116 (48.3%) were graduating seniors (Third grade).

Statistical analysis.

The analysis commenced by calculating descriptive statistics (including mean, median, and standard deviation) separately for each group. This facilitated an understanding of the distribution and central tendencies of the responses to questions related to climate change and agriculture role in it (Maravelakis, 2019).

Descriptive statistics were used to analyze demographic data, including age distribution, gender distribution, religious affiliation, and residential background. The Shapiro-Wilk test was conducted to assess the normality of the data, and non-parametric statistical tests were used due to non-normal distributions.

3- RESULTS AND DISCUSSION

3.1 CLIMATE CHANGE (CC)

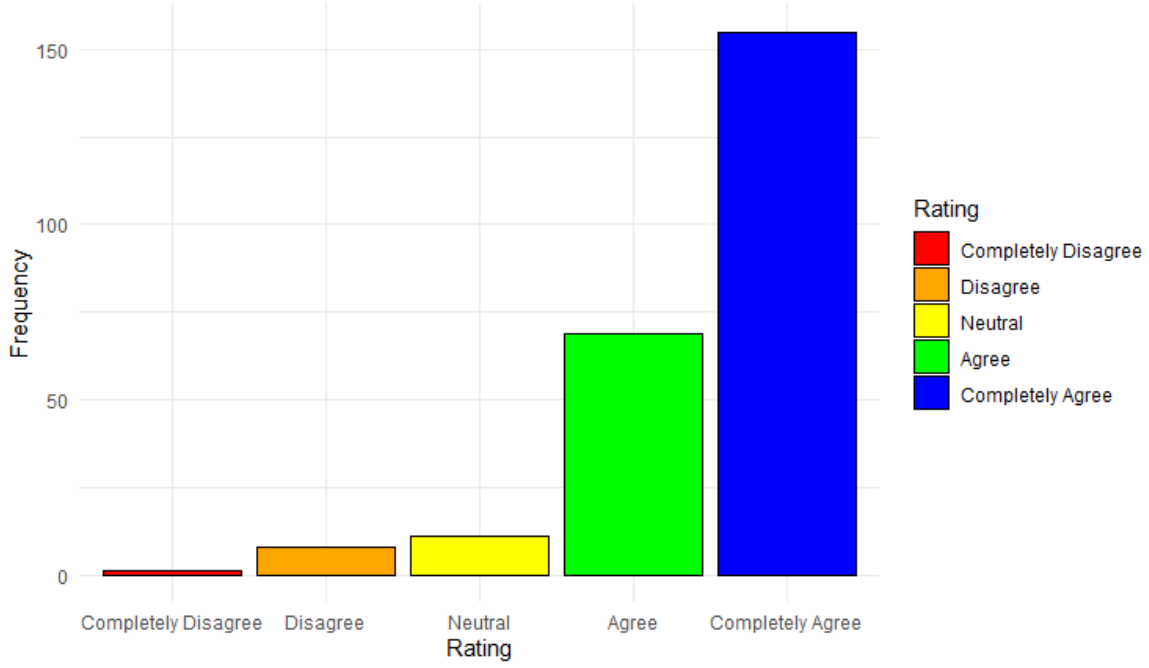
Climate change represents one of the key challenges addressed by the Sustainable Development Goals (SDGs) framework, holding significant importance for ensuring the long-term sustainability and well-being of communities, particularly in rural settings where vulnerability to climate-related risks may be higher (Cáceres et al., 2021; George et al., 2023; Jimoh et al., 2021; Matte, 2013; Ncube et al., 2016; Ofoegbu et al., 2017; Tregidgo et al., 2020; Zhou et al., 2022). Moreover, understanding students' perceptions of this critical global issue can provide insights into their awareness, concerns, and potential actions. By examining the importance attributed to climate change among students, the article contributes to understanding the role of education in fostering climate resilience and sustainability within local and global contexts.

As the SDGs address a broad range of interconnected global challenges, addressing climate change is essential for achieving several goals, including those related to poverty eradication, food security, health, and environmental sustainability (Ofoegbu et al., 2017) . In rural areas, communities often rely heavily on natural resources for their livelihoods, rendering them particularly vulnerable to climate change impacts such as extreme weather events, changes in precipitation patterns, and rising temperatures (Tregidgo et al., 2020; World Meteorological Organization., 2024). Therefore, students' awareness of and attitudes toward

climate change significantly influences their engagement with sustainable development efforts, resilience-building initiatives, and advocacy within their communities. Understanding students' perceptions within the SDGs framework can help tailor education and outreach efforts to effectively address local environmental challenges and promote sustainable development.

The first question we analyzed utilized a Likert scale to gauge students' perceptions regarding the significance of climate change as a global issue. This scale, commonly employed in surveys to measure attitudes and opinions, allowed students to express their level of agreement or disagreement with the statement “Climate change is an important global issue.” By using this method, we were able to capture a nuanced understanding of students' views on the urgency and importance of addressing climate change Figure 14.

Figure 14- Climate change is an important global issue.



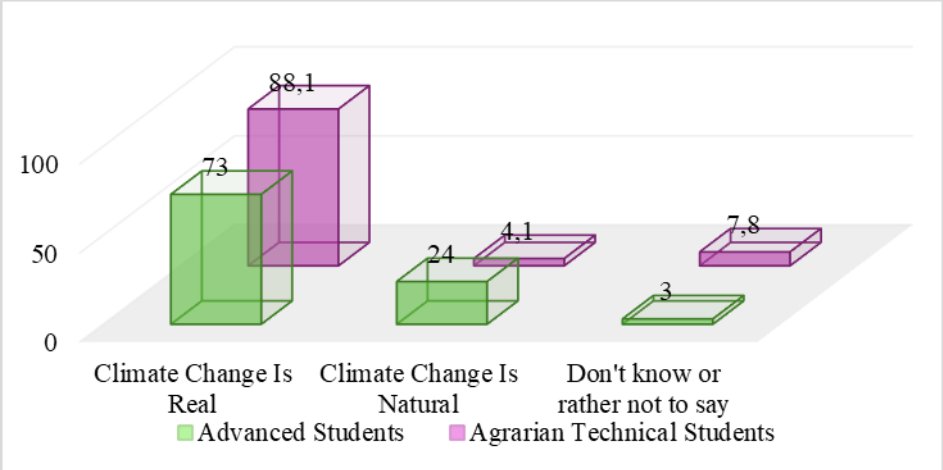
Source: The Authors (2024).

The majority of students completely agreed with the statement, followed by a significant number who agreed. A smaller number of students were neutral, disagreed, or

completely disagreed with the statement. This distribution indicates a strong consensus among the students acknowledging the importance of climate change as a global issue. The data reveals a strong acknowledgment of climate change as a real phenomenon among both advanced students and TVET agrarian students, suggesting an opportunity to strengthen climate education initiatives within education programs.

The next step we took was to compare the data from the question that assessed students' perceptions on climate change, specifically asking whether they believe climate change is real or if it is a natural phenomenon. This comparison aimed to uncover the level of understanding and belief among students regarding the human impact on climate change versus natural climate variability in Figure 15.

Figure 15- Climate change realization among students' cohorts.



Source: The Authors (2024)

By analyzing these responses, we aimed to identify any significant differences in perceptions, which could help in tailoring educational interventions and awareness campaigns to address misconceptions and enhance climate literacy among the student population. This step

was crucial in understanding how students interpret the causes of climate change and their readiness to engage in mitigation efforts based on their beliefs.

Among Advanced Students, the majority (73%) acknowledge that climate change is real, while a smaller percentage (24%) believe it is a natural phenomenon. The small percentage of respondents attributing climate change to natural causes suggests some divergence from scientific consensus, particularly among Advanced Students. According to Kiral Ucar et al. (2023) our consideration of climate change and behavioral choices might be shaped by our social environment, which might be the case of this disparity.

Silas Do Amaral (2023), emphasizes how political polarization and societal uncertainties hinder public awareness and cooperative action on climate change. It stresses the need for interdisciplinary scientific collaboration and effective dissemination of scientific knowledge to align public perception with scientific consensus, highlighting the complexities of societal and political influences on climate change awareness.

In addition, Afzali et al. (2024) delves into the regional differences in climate change denial within the U.S. and its impact on corporate environmental responsibility. This study finds that firms in counties with higher levels of climate change denial tend to have weaker environmental performance, are more likely to commit environmental violations, and impose greater environmental costs on society. It emphasizes that local beliefs about climate change significantly influence corporate behavior, suggesting that strong corporate governance and culture can mitigate the negative effects of climate change denial.

The acknowledgment of climate change as a real and pressing issue among the majority of advanced students underscores a foundational understanding of the challenges at hand. Their recognition of the intricate interplay between human activities and environmental changes reflects a commitment to evidence-based reasoning and scientific inquiry. However, the presence of a non-negligible minority attributing climate change to natural causes prompts

critical reflection on the dissemination of scientific knowledge and the influence of alternative narratives.

Exploring the factors underlying divergent beliefs among advanced students unveils a complex interplay of scientific literacy, cultural perspectives, and information sources. While scientific consensus overwhelmingly attributes climate change to human activities, such as greenhouse gas emissions and deforestation (IPCC, 2022b; MCTIC, 2021a, 2022), alternative narratives emphasizing natural variability such as (Lindzen, 1990) may gain traction in certain circles. The influence of socio-cultural factors, alongside the proliferation of misinformation and skepticism, underscores the need for nuanced approaches to climate communication and education.

Overall, the complexity and interdisciplinary nature of climate change as a subject, combined with the critical and questioning environment of advanced education, likely contribute to the greater variability in beliefs among Advanced Students. Esakkimuthu & Banupriya (2023) underscores the importance of effective climate education and communication strategies to empower students in addressing climate change. By equipping students with accurate information and a sense of agency, educators and policymakers can contribute to a more informed and ecologically responsible citizenry, thereby fostering a foundation for a sustainable future.

The data show contrasting results to those found by Natalia et al. (2023) investigating climate change awareness among students and faculty in Multan, Pakistan. It found higher awareness levels among teachers compared to students, with both groups recognizing similar environmental issues and impacts.

Similar results were found by Ofori et al. (2023), their team found that most students acknowledge climate change as real and human-induced but lack detailed knowledge, holding misconceptions about its causes and consequences. Factors such as education level, study

program, ethnicity, religion, and parents' occupation significantly influenced their climate change knowledge and perceptions.

Valkengoed et al. (2022) investigating how people's perceptions of climate change influence their actions to adapt to climate-related hazards conclude that stronger perceptions that climate change is real, human-caused, and has negative consequences are associated with greater support for adaptation policies, especially when these policies are presented as responses to climate change risks. In this direction, it is paramount that advanced students have a well-informed perception of climate change.

Leal Filho et al. (2021) exploring how universities worldwide are integrating climate change education (CCE) into their teaching and research programs, emphasizes the importance of interdisciplinary approaches and institutional commitment to fostering a climate-literate society. In the same sense, the divergence observed within the advanced student's demographic carries broader implications for climate action and policy formulation and especially education.

Addressing climate change necessitates collective action grounded in shared understanding and commitment. As future leaders and teachers in diverse fields, advanced students wield considerable influence in shaping public discourse and driving policy agendas. Bridging gaps in understanding and fostering consensus on the realities and causes of climate change thus emerges as a critical imperative for effective climate governance.

In the ongoing discourse surrounding climate change, the perspectives of TVET agrarian students emerge as a focal point, reflecting a unique blend of practical experience and academic insight within the realm of agricultural sciences. As we delve into their perceptions, a clear consensus emerges: the overwhelming majority (88.1%) recognize climate change as an undeniable reality. This resounding acknowledgment, coupled with a minimal fraction (4.1%) attributing it to natural causes, underscores a distinct divergence from alternative narratives prevalent among other demographics.

Morgado et al. (2017) assessing university students' perceptions in various countries, including Portugal, Mexico, and Mozambique, found that a vast majority of students believed climate change is happening. However, the level of confidence in this belief varied by country, with Mexican students showing less certainty compared to their counterparts in Portugal and Mozambique. Age also played a role, with older students expressing higher certainty about climate change's reality, which is just the opposite of what this research found, where younger students seem to be more conscious of climate change.

At the heart of agrarian TVET students' consensus lies a deep-seated understanding of the intricate nexus between climate dynamics and agricultural systems. Drawing from their hands-on experience and technical expertise, these students bear witness to the tangible impacts of climate change on crop yields, soil quality, and water availability. Their close engagement with the land affords them a grounded perspective, rooted in empirical observation and practical realities. As stewards of agricultural resilience, agrarian technician students are acutely attuned to the imperative of adapting to and mitigating the effects of climate change within agricultural contexts.

The minimal fraction attributing climate change to natural causes among agrarian technician students reflects a prevailing recognition of anthropogenic drivers underlying climatic shifts. While acknowledging the role of natural variability, they are keenly aware of the amplified influence of human activities, such as greenhouse gas emissions and land-use changes, in driving global environmental change. This nuanced understanding underscores a commitment to evidence-based reasoning and a recognition of the urgent need for collective action to address the root causes of climate change.

Kastrup & Winzier (2013) highlights the challenges faced by TVET due to technological and societal changes, environmental degradation, and climate change. It emphasizes the need for TVET to develop skills that promote a green economy and society.

Anåker et al. (2021) engaging with future nurses reveals that students perceive sustainability as a collective societal responsibility. They emphasize the importance of long-term planning and ensure that current actions do not adversely impact future generations.

The presence of uncertainty within both the advanced student and agrarian technician student cohorts highlights the complexity of climate change discourse and the diverse array of factors influencing individual perspectives. While the reasons underlying uncertainty may vary (from a lack of exposure to comprehensive climate science education to a genuine uncertainty about the veracity of available information) it is imperative to recognize and address these gaps in understanding. Failure to do so risks perpetuating misconceptions and hindering collective efforts to address climate change effectively.

The higher proportion of uncertainty among agrarian technician students suggests a specific need for tailored educational initiatives within agricultural contexts. As stewards of the land and frontline practitioners in agricultural systems, agrarian technician students play a pivotal role in shaping the resilience and sustainability of agricultural practices. However, their elevated uncertainty regarding climate change underscores a potential gap in climate literacy and awareness within agrarian education programs. By enhancing climate education curricula and integrating climate-related topics into practical training modules, agrarian institutions can empower students to navigate the complexities of climate change with confidence and clarity.

Furthermore, addressing uncertainty among both advanced students and agrarian technician students requires a multifaceted approach that incorporates diverse learning modalities and engages with the unique perspectives and experiences of each cohort. Interactive workshops, experiential learning opportunities, and community-based initiatives can serve as effective platforms for fostering dialogue, critical thinking, and knowledge exchange.

The overwhelming acknowledgment of climate change as a real phenomenon among both groups reflects a general acceptance of scientific consensus on the issue, it also underscores the importance of integrating climate education into agricultural curricula.

Climate change significantly impacts various aspects of agricultural practices, ranging from crop selection and timing of planting and harvesting to irrigation management, pest control, and soil health (Pinto et al., 2020). By grasping the intricacies of climate change, students can develop adaptive strategies tailored to shifting environmental conditions, thereby enhancing the sustainability and productivity of agricultural systems (Reimers, 2021).

Agriculture stands particularly vulnerable to climate variability and extreme weather events like droughts, floods, and heatwaves, which have become more frequent and severe due to climate change (Birkmann et al., 2022). Equipped with an understanding of climate change dynamics, students can explore resilience-building measures within agricultural systems, such as integrating drought-resistant crops, adopting water-efficient irrigation methods, and embracing diversified farming approaches (Reimers, 2021)

Moreover, climate change poses significant threats to global food security by disrupting crop yields, livestock productivity, and food distribution networks (FAO, 2015). As key stakeholders, agriculture students are instrumental in safeguarding future food security through innovative solutions that mitigate climate change impacts on agricultural production and distribution channels (Handayani, 2021).

It is reasonable to expect that agricultural students would have a deeper understanding of the importance of climate change compared to more advanced students, as not all advanced students necessarily come from agricultural studies backgrounds. Climate change science is inherently interdisciplinary, integrating insights from science, social studies, ethics, and other fields. This holistic perspective would help students grasp the interconnectedness of environmental issues with broader social, economic, and political dynamics (Freire, 2013,

2014; Handayani, 2021), requiring educators to integrate knowledge from diverse fields such as meteorology, ecology, and agronomy, all of which are already well-integrated into agrarian technician curricula. However, implementing this interdisciplinary approach can pose challenges within traditional academic courses.

Furthermore, as aspiring agricultural professionals, students must engage with policymakers, stakeholders, and communities to tackle climate change challenges effectively. Proficiency in climate change science, impacts, and adaptation strategies empowers students to advocate for evidence-based policies and practices conducive to climate-resilient agriculture and rural development.

Education, as advocated by (Freire, 2013, 2014) as a practice of freedom, holds the potential to bolster societal resilience. By fostering awareness, critical reflection, and active engagement among learners, education empowers both individuals and communities to confront challenges and adversities with greater efficacy. Through this process, people acquire the skills, knowledge, and attitudes necessary to navigate and surmount difficult circumstances, thereby playing a vital role in cultivating a more resilient society.

To foster a culture of dialogue and critical thinking in education, educators should actively involve students in questioning and exploring the realities they confront. This approach holds relevance in technical courses, where students can benefit from comprehending the scientific evidence of ongoing changes and devising strategies to address and potentially reverse them. It entails challenging students' assumptions and beliefs through open-ended inquiries, prompting them to reflect on their experiences and consider diverse perspectives (Freire, 2003, 2011, 2013, 2014).

Furthermore, emphasizing the importance of horizontal dialogue, wherein educators and learners collaborate as equal partners in the learning process, departs from the traditional vertical dynamic where the educator is solely perceived as the holder of knowledge.

Additionally, education should be tailored to students' realities, considering their needs and aspirations, and should adopt a critical approach enabling the analysis of social and political structures shaping their lives.

In this regard, empowering marginalized groups, such as rural communities, to advocate for change is paramount (Freire, 2003, 2011, 2013, 2014). Providing students with the tools and skills to become environmental activists and agents of change in their communities is essential for fostering a sense of agency and responsibility towards addressing environmental challenges effectively.

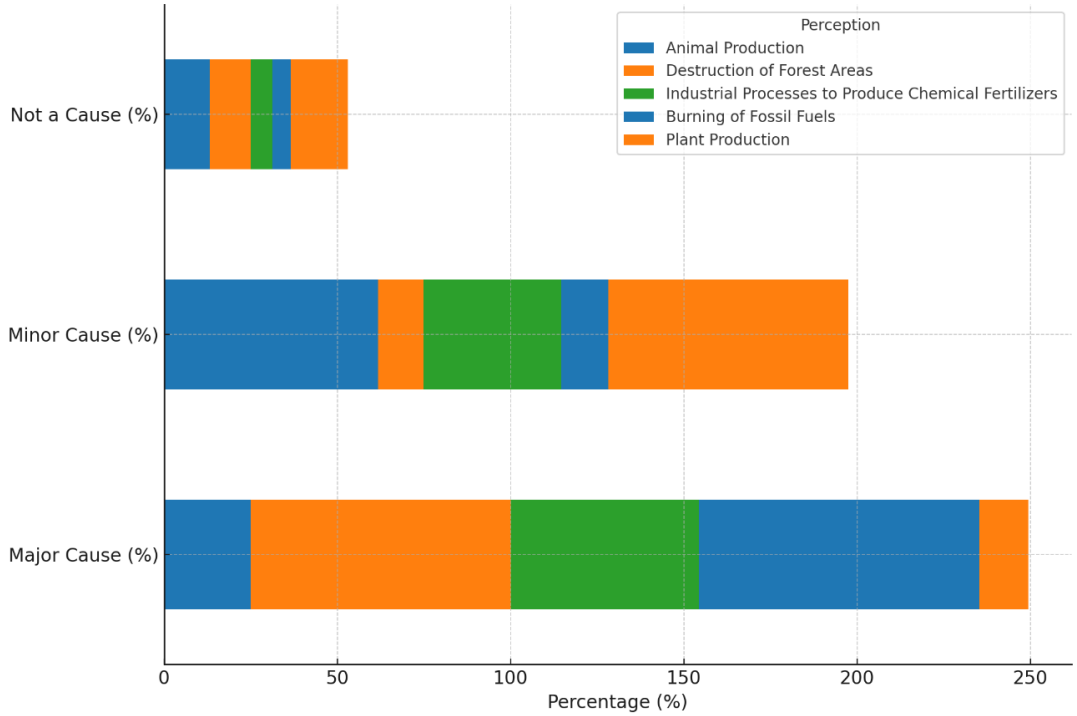
These insights can inform tailored educational interventions by educators and policymakers to address misconceptions and enhance understanding of the anthropogenic drivers of climate change. By nurturing critical thinking and providing access to accurate, climate science information, educators can empower students to actively participate in discussions and initiatives aimed at mitigating and adapting to climate change.

3.2 FARMING AND CLIMATE CHANGE (CC)

We began this section by asking students to rank various agricultural activities in terms of their impact on climate change, categorizing each activity as a minor, major, or non-cause. This approach was intended to gauge students' understanding of the relationship between agriculture and climate change, and to identify which specific practices they perceive as most and least harmful (Figure 16).

By evaluating their responses, we aimed to identify common misconceptions and knowledge gaps, which could inform future educational strategies. This ranking exercise was crucial in assessing students' awareness of the environmental consequences of various agricultural practices and their overall impact on climate change.

Figure 16-Perceptions of the major causes of climate change.

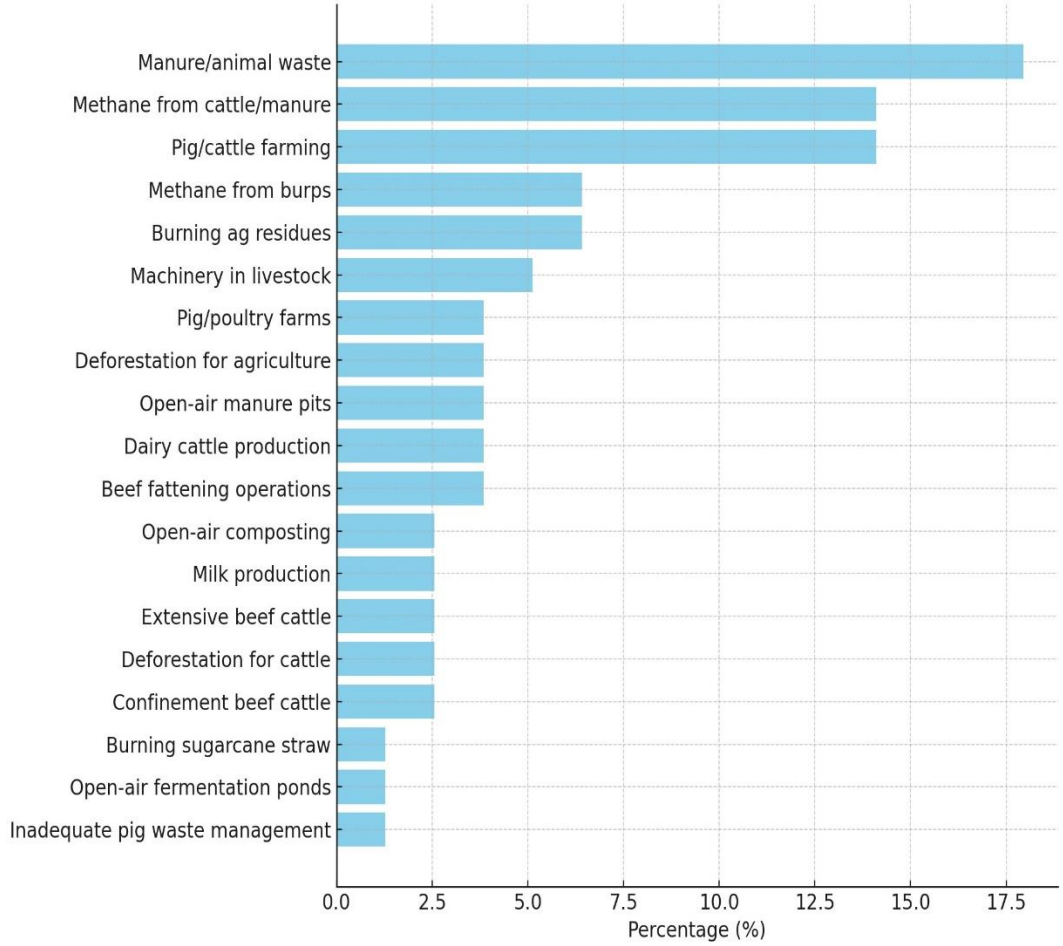


Source: The Authors (2024).

The graph indicates a well-informed recognition of the significant contributors to climate change, with fossil fuels and deforestation leading as major causes. This aligns with broader environmental policies and scientific research, emphasizing the need for targeted and holistic approaches in addressing climate change.

Unsustainable agricultural practices significantly contribute to global warming and climate change by prioritizing short-term economic gains over long-term environmental sustainability. These practices put immense pressure on ecosystems, biodiversity, and the climate system. Students identified several key harmful practices in an open-ended question, which are illustrated in Figure 17.

Figure 17- Agricultural activities connected to climate change**.**



Source: The Authors (2024).

While meat can provide essential nutrients, treating it like an “all you can eat buffet” overlooks the potential health risks and environmental consequences associated with excessive consumption. Instead, adopting a diet characterized by moderation and diversity not only supports optimal health but also helps mitigate the environmental impact of food production. By emphasizing moderation and incorporating a variety of foods into our diets, we can strive for a more balanced approach to both personal health and environmental stewardship.

It appears that there is a consensus among students regarding the significant contribution of animal concentration to greenhouse gas emissions. Particularly noteworthy are large-scale production operations involving pigs, cattle, poultry, and dairy, which underscore

concerns regarding inadequate animal waste management. It's worth noting that these industries represent the largest animal industry chain in the study region.

Livestock farming, particularly large-scale industrial operations, generates significant greenhouse gas emissions, primarily methane (CH_4) and nitrous oxide (N_2O). Methane, produced during enteric fermentation in ruminant animals like cattle, is a potent greenhouse gas with a much higher warming potential than CO_2. Livestock farming, particularly ruminant animals like cattle, sheep, and goats, is a major source of greenhouse gas emissions. The digestion process in ruminants produces methane, a potent greenhouse gas that contributes to global warming. Additionally, manure management and feed production also release methane and nitrous oxide, further exacerbating climate change (IPCC, 2007, 2022a).

The expansion of livestock farming often leads to deforestation, especially in regions like the Amazon rainforest. Deforestation releases stored carbon into the atmosphere and reduces the Earth's capacity to absorb greenhouse gases, contributing to climate change. Clearing forests for cattle ranching is a significant driver of deforestation and carbon emissions (MCTIC, 2021b).

According to D'Silva & Webster (2010) intensive livestock farming practices can lead to biodiversity loss and environmental degradation, highlighting the need for more sustainable farming methods, such as the one that organic farming offers. Organic farming can help maintain soil health, reduce the use of synthetic inputs, and promote biodiversity conservation.

Enhancing the efficiency of breeding and feeding strategies in livestock production is crucial for reducing greenhouse gas emissions and other environmental impacts. This includes optimizing the balance between carbohydrate and protein in animal diets to minimize waste and emissions. Certain dietary measures, like incorporating ionophores as supplements, have been shown to effectively decrease greenhouse gas (GHG) emissions without compromising animal welfare. Moreover, some dietary strategies may even enhance animal welfare. For instance,

initiatives aimed at mitigating direct methane (CH_4) emissions can boost energy availability, thereby improving the energy balance, which is particularly crucial for high-producing animals (Llonch et al., 2017).

According to (Litre et al., 2022) as production systems intensify their input usage, they improve productivity and exhibit better performance concerning greenhouse gas emissions. However, these intensified systems tend to fare poorly in terms of energy consumption and soil erosion, resulting in increased surpluses of phosphorus (P) and nitrogen (N) and posing a heightened risk of pesticide contamination.

Utilizing crop-livestock-forestry systems emerges as a viable approach to mitigating greenhouse gas emissions while bolstering the sustainability of forage-based livestock systems. Integrated systems not only enhance meat and grain production but also effectively offset GHG emissions. Moreover, systems incorporating crops yield three times more human-edible protein and incorporate an additional 270 kg N/ha over four years. Additionally, forestry systems play a crucial role in carbon sequestration, with potential sequestration ranging from 15.9 to 20.4 Mg CO_2eq/ha/year (Monteiro et al., 2024).

National governments can play a significant role in promoting sustainable meat production and consumption through regulations, trade policies, and development cooperation initiatives. By incentivizing the production and consumption of sustainable meat products, governments can drive positive changes in the industry. These strategies emphasize the importance of a multi-faceted approach involving consumers, businesses, governments, and international cooperation to address the challenges posed by unsustainable meat production and consumption.

Students also appear to prioritize concerns regarding land use, deforestation, and biomass burning. This encompasses apprehensions regarding the clearance of new land for agricultural purposes, a practice frequently resulting in deforestation and heightened wildfire

risks. Moreover, the expansion of cattle breeding areas through deforestation raises significant alarms, as it not only leads to habitat loss and declines in biodiversity but also exacerbates carbon emissions and contributes to climate change.

The clearing of forests for agricultural expansion, particularly in regions like the Amazon rainforest, releases vast amounts of carbon dioxide (CO_2) stored in trees and soil into the atmosphere. Deforestation not only reduces carbon sequestration capacity but also diminishes biodiversity and disrupts local and global climate patterns.

According to Oliveira et al. (2021) extensive deforestation of the Amazon rainforest will significantly amplify the likelihood of exposure to extreme heat linked to climate change at both local and regional levels. These elevated temperatures, reaching levels intolerable to human physiology, will have profound impacts on highly susceptible areas.

The widespread practice of burning agricultural biomass waste, such as sugarcane straw, warrant reevaluation (Jain et al., 2014). This practice not only leads to the emission of greenhouse gases but also results in nutrient loss and air pollution, which can present a great health risk for urban and rural populations (Paraiso & Gouveia, 2015). Therefore, alternative methods of disposal should be explored to mitigate these environmental impacts.

Addressing unsustainable agricultural practices is crucial for mitigating climate change and building resilience in agricultural systems. Transitioning towards agroecological approaches that promote biodiversity, soil health, and water conservation can help reduce greenhouse gas emissions, enhance carbon sequestration, and improve the overall sustainability of food production. Agriculture is both a contributor to and a victim of climate change, as agricultural activities can produce greenhouse gas emissions and contribute to deforestation, while climate change can adversely affect agricultural productivity and natural resources (HYLAND et al., 2016). By understanding the connections between agriculture and climate

change, students can become advocates for sustainable agricultural practices that mitigate greenhouse gas emissions, conserve biodiversity, and protect ecosystems.

According to Hyland et al. (2015), even among farmers there appears to be a discrepancy of perceptions regarding agriculture's impact on climate change. While farmers generally acknowledge the existence of climate change, there may be a lack of full comprehension or acceptance regarding their own sector's role in exacerbating the issue. Specifically, certain farmer types demonstrate low levels of awareness concerning climate change and may not recognize the significant contribution of livestock emissions to the phenomenon. This failure to grasp or acknowledge responsibility for agricultural emissions can hinder effective engagement and impede the implementation of proactive measures to mitigate climate change.

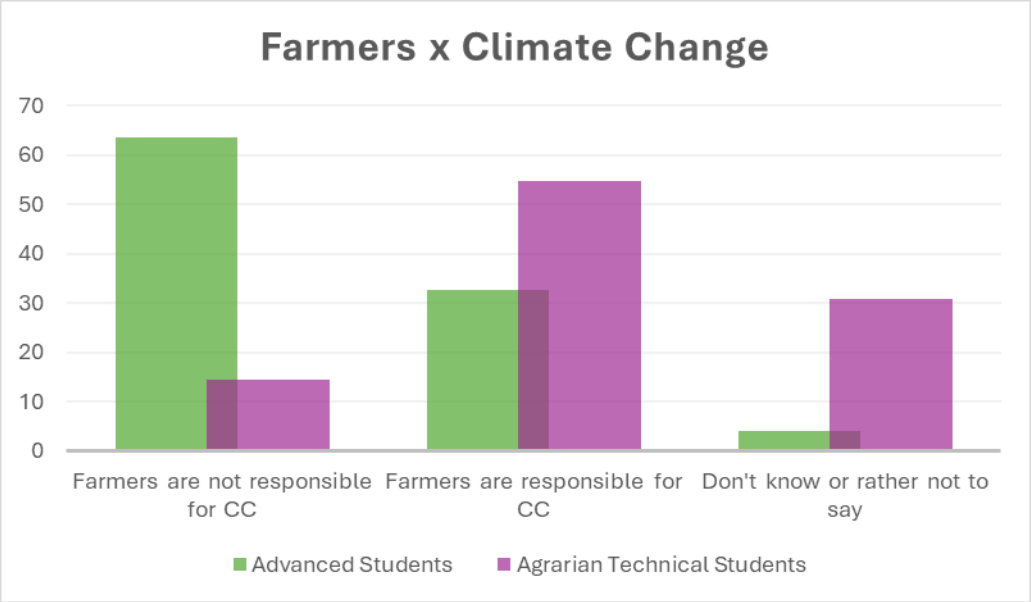
Family farmers, much like most public policymakers, often base their decisions not only on scientific evidence but also on their own life experiences or even information provided by non-scientific stakeholders including the media (LITRE et al., 2015). The graph below (Figure 18), highlights divergent perspectives on farmers' responsibility for climate change between Advanced Students and Agrarian Technician Students, emphasizing the need for targeted educational interventions and open discussions to enhance environmental literacy and promote sustainable practices within the agricultural community.

Among advanced students, a majority (63.5%) believe that farmers are not accountable for climate change, indicating they likely attribute environmental issues to other sectors such as industrial practices or governmental policies. However, 32.5% of these students recognize farmers' responsibility, acknowledging agriculture's environmental impact through activities like deforestation and methane emissions.

In contrast, among Agrarian Technician Students, only 14.4% believe farmers are not responsible for climate change, while a majority (54.7%) see farmers as accountable. This

suggests a strong recognition of the significant environmental impact of agricultural practices within this group. The notable percentage of respondents in both groups expressing uncertainty 4% among advanced students and 30.9% among Agrarian TVET Students highlights varying levels of familiarity and confidence in discussing the relationship between agriculture and climate change. This underscores the need for comprehensive education and dialogue on sustainable agricultural practices and their role in climate change mitigation. On the graph below, we analyze TVET students' perspectives on the idea that the economic sectors that pollute the environment should be penalized accordingly (Figure 19).

Figure 18- Students' perceptions of farming accountability for climate change.

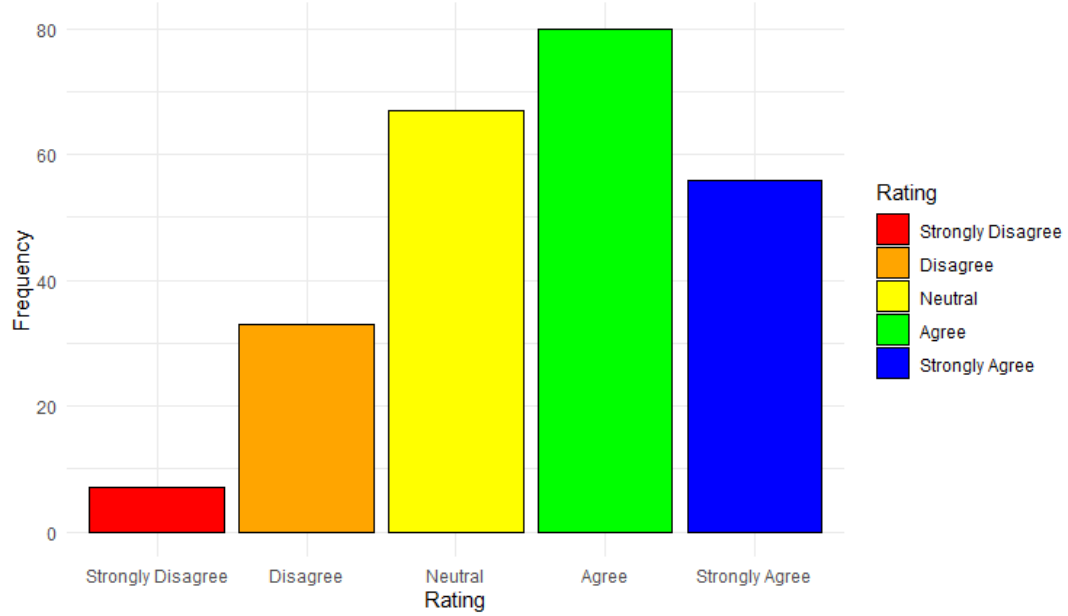


Source: The Authors (2024).

The graph indicates strong support for penalizing the most polluting economic sectors, with the majority of respondents agreeing or strongly agreeing with the statement. This support provides a mandate for policymakers to pursue stricter environmental regulations while also emphasizing the need for education and communication to address uncertainties and opposition.

The juxtaposition of these graphs highlights a nuanced understanding of climate change among students. While agrarian technical students are more inclined to recognize the role of agriculture in contributing to climate change, both groups collectively support the idea of penalizing major polluters. This suggests that while specific sectors like agriculture may be perceived differently, there is a broad consensus on the need for accountability and regulatory measures for industries that significantly impact the environment.

Figure 19- Penalize polluters: The necessity of penalizing the most polluting economic sectors.



Source: The Authors (2024).

Many farmers acknowledge the significant impact of agricultural practices on the environment, particularly through activities such as deforestation, methane emissions from livestock, and the use of chemical fertilizers. However, there is a notable degree of skepticism among some farmers regarding the extent of agriculture's contribution to climate change, with some attributing the primary responsibility to other sectors such as industry and transportation

Addressing the issue of low familiarity with climate change among Agrarian Technician Students is paramount for fostering informed discussions and effective decision-making within agricultural communities. Tailored education for climate change is crucial in bridging these gaps and equipping students with the necessary understanding and skills to address environmental challenges within agricultural practices. By providing targeted training and resources, tailored education can empower students to navigate complex issues like climate change with confidence, fostering a deeper understanding of the interplay between agricultural activities and environmental sustainability.

One approach to tackling this challenge is through the organization of educational workshops tailored specifically to inform students about climate change and its impacts on agriculture. These workshops can feature presentations, case studies, and interactive activities led by experts in the field, providing students with a foundational understanding of the topic.

Additionally, integrating climate change topics into the curriculum of agrarian technician programs can ensure sustained exposure to the subject matter, thereby deepening students' knowledge over time. Field visits to farms implementing sustainable practices and agroecological techniques can offer invaluable experiential learning opportunities, allowing students to witness firsthand the intersection of climate change and agriculture. Peer learning and mentorship initiatives can further support students in their educational journey, fostering collaborative learning environments where knowledge-sharing and mutual support are encouraged.

Access to resources such as books, scientific journals, and online courses can empower students to continue their education independently, while engagement with local experts through guest lectures and panel discussions can provide valuable insights and perspectives. By promoting critical thinking, discussion, and practical projects within the classroom, agrarian

technician programs can cultivate a cohort of students equipped with the knowledge, skills, and confidence to address the complex challenges posed by climate change in agriculture.

Furthermore, by addressing uncertainties and reservations directly through tailored education initiatives, educators can create inclusive learning environments where students feel supported in exploring and discussing topics related to climate change. This approach not only enhances students' knowledge and awareness but also promotes a sense of agency and responsibility in actively addressing environmental issues within their respective fields of study and practice.

These findings underscore the importance of promoting environmental education and awareness, particularly within agricultural education programs. For (Ma et al., 2023) environmental knowledge, climate change awareness, and environmental attitudes can positively influence pro-environmental intentions among university students.

Educators and policymakers should prioritize addressing misconceptions or gaps in understanding regarding the agricultural sector's contribution to climate change among both student groups. Encouraging dialogue and providing access to accurate information about the relationship between agriculture and climate change can help cultivate a more informed and proactive stance among future agricultural professionals.

Educators and policymakers can harness the insights garnered from this research to bolster environmental education efforts in several impactful ways. Firstly, integrating environment-related courses into study plans across disciplines as compulsory subjects can furnish students with foundational knowledge on environmental issues, thereby instilling a sense of environmental responsibility from an early stage.

As students of the rural field, acknowledging the role of agricultural practices in contributing to climate change reflects an understanding of the collective responsibility within the field. It signifies recognition that production systems are not immune to environmental

impacts and underscores the importance of addressing these challenges. By accepting this reality, a commitment to proactive measures aimed at improving agricultural practices and mitigating environmental impact is demonstrated. This stance also implies a dedication to accountability, acknowledging that deficiencies in production methods can have broader consequences. Embracing this perspective empowers us as a collective to pursue sustainable farming methods, adopt technologies that minimize emissions, conserve natural resources, and enhance resilience in the face of climate variability. Ultimately, taking collective responsibility for our contributions to climate change enables us to actively seek solutions and contribute to the development of a more sustainable and resilient agricultural sector and rural communities.

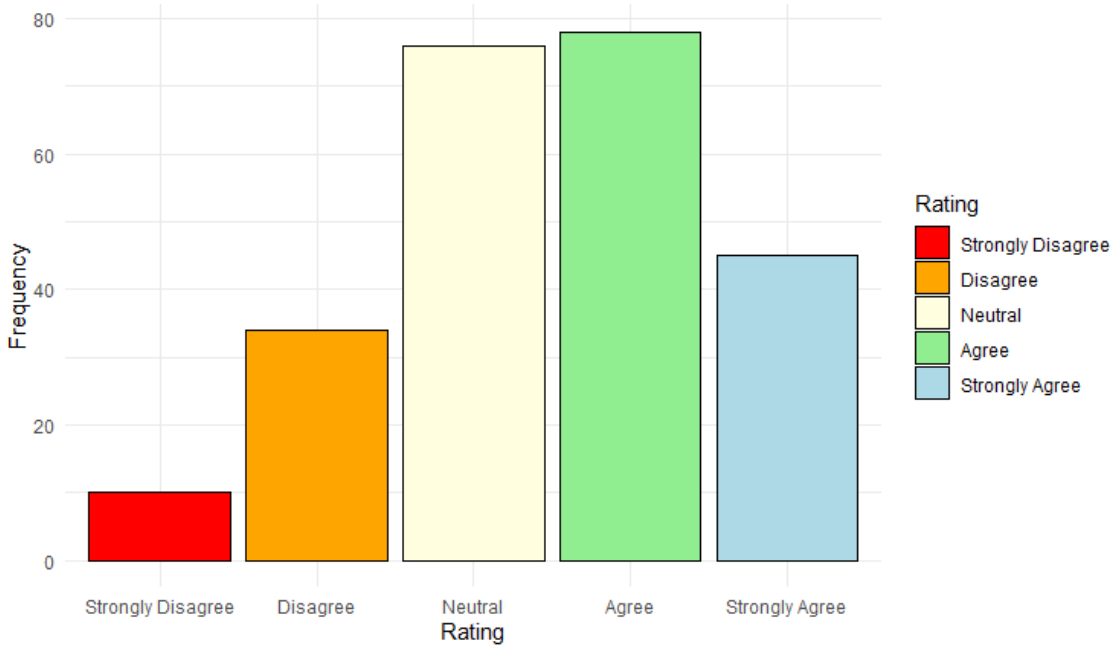
3.3 SO WHAT? STUDENTS PERSPECTIVES ON CLIMATE CHANGE MITIGATORS

Understanding students' perspectives on climate change mitigators is essential for shaping effective educational strategies and policies. This section delves into the various climate change mitigation strategies identified by students, highlighting their awareness and attitudes towards these measures. By analyzing student responses, we aim to identify the most and least recognized mitigators, uncover any prevalent misconceptions, and determine the overall level of climate literacy among the student population. Such insights are crucial for designing targeted interventions that can empower students to actively participate in climate action and advocate for sustainable practices.

The first step we took was to analyze students' perceptions of the feasibility of reducing emissions without compromising production levels. This involved examining their views on the balance between maintaining economic growth and implementing effective emission reduction strategies Figure 20.

By evaluating their responses, we aimed to understand the degree of optimism or skepticism among students regarding the potential for technological advancements and policy measures to achieve this balance. The insights gained from this analysis are crucial for developing educational programs that address the practical challenges and opportunities in mitigating climate change while sustaining production.

Figure 20- The feasibility of reducing emissions without reducing production.



Source: The Authors (2024).

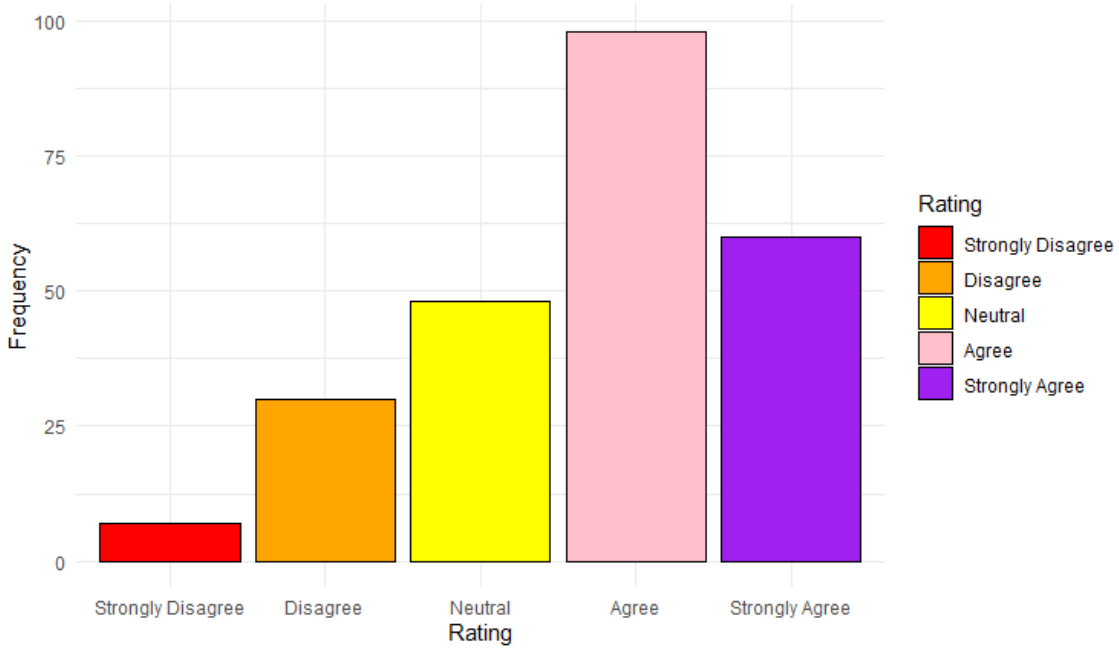
The graph displays the distribution of ratings on the feasibility of reducing greenhouse gas emissions without reducing agricultural production. The ratings are measured on a Likert scale, ranging from “Strongly Disagree” to “Strongly Agree”. The predominant agreement (both “Agree” and “Strongly Agree”) suggests a generally positive outlook among respondents regarding the potential for sustainable agricultural practices that can reduce emissions. Given

the high agreement, there is likely support for policies that promote emission reduction technologies and practices in agriculture.

The notable number of “Neutral” responses indicates that there is still a significant portion of respondents who might need more information or are unsure about the specifics of how such reductions can be achieved. The presence of neutral responses suggests a need for further education and dissemination of information on successful case studies and methods for reducing emissions without harming production.

Following this, we asked students, using a Likert scale question, if they believe it is feasible to increase agricultural profits while preserving the environment. This inquiry aimed to gauge students' confidence in the potential for sustainable agricultural practices to achieve both economic and environmental objectives Figure 21.

Figure 21-Increase profits and preserve the environment: feasibility of increasing agricultural profits while preserving the environment.

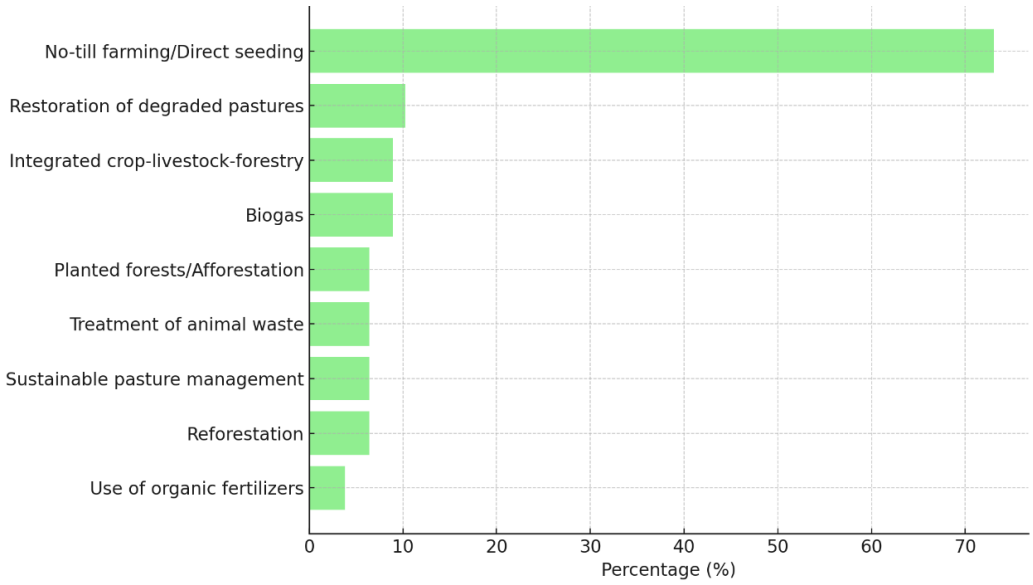


Source: The Authors (2024).

By assessing their responses, we aimed to understand how students perceive the balance between profitability and environmental conservation in agriculture. This step was crucial in identifying the level of optimism or skepticism towards the integration of sustainable practices in the agricultural sector and provided insights into areas where educational efforts could be enhanced to promote a better understanding of sustainable development.

The final step in our analysis involved asking students, through an open-ended question, which agricultural activities they believe are connected to climate change mitigation. This question aimed to capture a wide range of perspectives and insights from students regarding the specific practices that they associate with reducing the impacts of climate change. By gathering their responses, we aimed to identify common themes and innovative ideas that students perceive as effective strategies for climate change mitigation within the agricultural sector Figure 22.

Figure 22- Agricultural activities connected to climate change mitigation.



Source: The Authors (2024).

This qualitative data provided a deeper understanding of students' knowledge and beliefs about sustainable agricultural practices, highlighting areas where further education and advocacy might be needed to enhance their engagement with climate action initiatives. Further Research should incorporate more studies to identify and refine methods that balance emission reduction and agricultural productivity, addressing any specific concerns from the skeptical respondents. By addressing these areas, it is possible to build on the existing positive outlook and further promote sustainable agricultural practices that are both environmentally and economically beneficial.

Addressing the concerns of the disagreeing respondents through targeted communication and demonstration projects could help shift perceptions and increase overall confidence in sustainable practices. Such communication includes the work of Ahmed et al. (2020) on agriculture and climate change, where they outline various efficient farming practices that can achieve significant emissions reductions without sacrificing agricultural output. These practices include optimizing fertilizer use, adopting no-till farming, and improving livestock management.

Agroforestry, a production system that combines trees, shrubs, and agricultural crops on the same land to promote biodiversity and food production. Integrating climate-smart agricultural practices, such as agroforestry, crop rotation, and precision agriculture, can increase resilience to climate variability while reducing environmental impacts.

By prioritizing sustainable agriculture, we can mitigate the contribution of farming to global warming and foster a more resilient and sustainable food system for future generations. With the adoption of sustainable agricultural techniques, such as the use of organic fertilizers (manure and composting replacing chemical fertilizers), integrated pest and disease management (decreasing the use of chemical pesticides), soil conservation, crop diversification, the use of heirloom seeds, and the integration of crop and livestock farming (ALTIERI et al.,

2005; ALTIERI et al., 2011; ALTIERI & NICHOLLS, 2003), we might have a chance of mitigating the climate change.

Sustainable agriculture encompasses a range of practices and approaches that mitigate global warming and climate change while promoting environmental stewardship, resilience, and food security. These practices leverage ecological principles and traditional knowledge to enhance ecosystem health, conserve natural resources, and reduce greenhouse gas emissions.

These findings underscore the importance of targeted educational initiatives to address sector-specific perceptions and emphasize holistic approaches to climate mitigation. The alignment on penalizing polluters reflects a shared commitment to environmental responsibility, indicating potential support for policies that balance agricultural practices with broader environmental goals.

Suggested adaptive approaches to address the impacts of climate change on agriculture involve seeking out heat-tolerant genotypes that are proficient in water and nutrient utilization and resilient to diseases and emerging pests in changing climatic conditions. Additionally, it is proposed to create production systems that can alleviate the effects of climate change on agricultural output and encourage the absorption of carbon in soils. Conservation agriculture emphasizes minimal soil disturbance, permanent soil cover, and diversified crop rotations to improve soil health and productivity while reducing erosion and greenhouse gas emissions. By minimizing tillage, conserving soil moisture, and enhancing organic matter accumulation, conservation agriculture practices promote carbon sequestration in agricultural soils (EMBRAPA, 2015).

According to the research, 73% of student's cohorts consider no-till farming as one of the most useful technics for climate change mitigation. No-till farming and direct seeding exemplify innovative approaches to soil management. These methods effectively mitigate

erosion, improve soil health, and conserve moisture, thereby promoting long-term sustainability in agriculture.

Non-till farming also referred to as no-till or zero tillage farming, presents a compelling strategy for farmers to confront the challenges posed by climate change. By minimizing soil disturbance and leaving crop residues intact, non-till farming effectively addresses several key climate-related concerns (Albuquerque et al., 2013; Altieri et al., 2011; Fayad et al., 2019). Firstly, it mitigates soil erosion by protecting the soil surface from wind and water erosion, crucial in regions vulnerable to extreme weather events intensified by climate change. Moreover, the practice promotes carbon sequestration by enhancing the accumulation of organic matter in the soil, thereby contributing to the reduction of greenhouse gas emissions. Additionally, non-till farming fosters improved soil health, preserving soil structure and microbial activity, which are essential for nutrient cycling and water retention.

The no-till farming increases resilience to climate-related stresses such as droughts and heavy rainfall, which are more frequent each day due to extreme climate. Furthermore, by acting as a natural mulch, crop residues reduce water evaporation and enhance soil moisture retention, helping farmers cope with water scarcity and drought conditions. The energy efficiency of non-till farming, requiring less mechanical soil tillage and consequently reducing fuel consumption and greenhouse gas emissions from farm machinery, further underscores its climate-friendly nature. Lastly, by providing habitat and food sources for beneficial soil organisms and wildlife, non-till farming fosters biodiversity preservation, crucial for building ecological resilience in the face of climate change impacts. In essence, non-till farming offers a comprehensive suite of benefits that not only help farmers adapt to climate change but also contribute to sustainable agriculture and food security (Fayad et al., 2019).

Among the most mentioned practices, the ones involving forestry are noteworthy. Agroforestry integrates trees or shrubs with crops or livestock, diversifying agricultural

landscapes and enhancing ecosystem services. Trees sequester carbon dioxide (CO_2) from the atmosphere through photosynthesis, storing carbon in biomass and soil. Agroforestry systems not only sequester carbon but also provide additional benefits such as improved soil fertility, water retention, and habitat for biodiversity (Altieri, 2004; Altieri et al., 2011; Altieri & Nicholls, 2012).

Agroforestry systems represent a form of integrated land use, particularly suitable for marginal areas and low-input systems. The objective of these systems is to optimize the beneficial effects of interactions between woody components and other plant and animal components, aiming to achieve a production pattern superior to monocultures while utilizing the same available resources and considering the determined social, ecological, and economic conditions (Rebello & Sakamoto, 2021).

Crop diversification and rotation enhance resilience to climate variability and pest pressures while reducing reliance on chemical inputs. Diverse cropping systems improve soil structure, nutrient cycling, and pest management, thereby reducing greenhouse gas emissions associated with fertilizer and pesticide use. Additionally, leguminous cover crops can fix atmospheric nitrogen, reducing the need for synthetic fertilizers and mitigating nitrous oxide (N_2O) emissions (Guilherme Bulegon et al., 2016).

Sustainable livestock management practices, such as rotational grazing, silvopastoral systems, and improved feed efficiency, can reduce methane (CH_4) emissions from livestock farming (Guimarães et al., 2023; Matte & Waquil, 2020). Integrating livestock with perennial pastures or agroforestry systems enhances carbon sequestration while improving animal welfare and overall farm productivity.

While intensive animal production is widely acknowledged as a significant contributor to climate change, it's important to recognize that not all forms of animal production have equally negative environmental impacts. Research has indicated that integrating an arboreal

component into production systems can provide several environmental benefits, including increased resilience to droughts, mitigation of increased air humidity effects, reduced temperature impacts, and lowered fire risks (Assad et al., 2022).

Conservation measures such as organic farming can help maintain soil health, biodiversity, and reduce the use of artificial fertilizers and pesticides in meat production. Returning animal manures to the soil and utilizing anaerobic digesters for energy production are also highlighted as sustainable practices (Braun et al., n.d.).

The insights gathered from analyzing students' perspectives on climate change mitigators underscore the importance of targeted educational initiatives and informed policymaking. By examining the feasibility of reducing emissions without compromising production, the balance between increasing agricultural profits and preserving the environment, and identifying agricultural activities linked to climate change mitigation, we have highlighted key areas of optimism and skepticism among students. These findings reveal a generally positive outlook on the potential for sustainable agricultural practices but also indicate significant gaps in knowledge that need to be addressed.

4- CONCLUSIONS

The study provides valuable insights into the perceptions of advanced students and agrarian technician students regarding climate change and its implications for agriculture. The findings highlight several critical points that can inform future educational strategies, policy development, and practical interventions aimed at fostering sustainable agricultural practices in Brazil.

Both advanced students and agrarian technician students demonstrated a strong acknowledgment of climate change as a real and pressing issue. This consensus underscores the

importance of integrating climate education into agricultural curricula to enhance understanding and engagement with climate resilience strategies.

Students showed a generally positive outlook on the feasibility of reducing greenhouse gas emissions without compromising agricultural production. This optimism indicates support for policies and technological advancements that promote sustainable agricultural practices. However, the notable number of neutral responses suggests a need for further education and dissemination of successful case studies to build confidence in these strategies.

The inquiry into the feasibility of increasing agricultural profits while preserving the environment revealed varied levels of confidence among students. Understanding these perceptions is crucial for designing educational programs that emphasize the compatibility of economic and environmental goals in agriculture. Highlighting successful examples of sustainable practices can enhance students' confidence in achieving these dual objectives.

Students identified various agricultural activities connected to climate change mitigation, demonstrating a well-informed recognition of significant contributors to climate change, such as fossil fuels and deforestation. This understanding aligns with broader environmental policies and scientific research, emphasizing the need for targeted and holistic approaches in addressing climate change.

The study revealed common misconceptions and knowledge gaps among students, particularly regarding the human impact on climate change versus natural climate variability. Addressing these gaps through targeted educational interventions can enhance climate literacy and prepare students to engage effectively in climate action initiatives.

Both groups showed strong support for penalizing the most polluting economic sectors, indicating a shared commitment to environmental responsibility. This consensus provides a mandate for policymakers to pursue stricter environmental regulations while also emphasizing the need for continuous education and communication to address any uncertainties.

Tailored educational initiatives, such as workshops, field visits, and integration of climate change topics into curricula in both cohorts, can significantly enhance students' understanding and readiness to adopt sustainable agricultural practices. Promoting critical thinking, experiential learning, and community-based initiatives will empower students to navigate the complexities of climate change and advocate for sustainable solutions.

By leveraging these insights, educators and policymakers can develop comprehensive educational programs that not only inform but also empower students to actively participate in climate action. Fostering a well-informed and proactive student population is essential for driving transformative changes towards a sustainable future, where economic growth and environmental conservation are harmoniously balanced.

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3- OVERALL CONCLUSION

The integration of sustainability education into the curriculum is paramount in addressing the pressing challenges of climate change and promoting sustainable development. This research has highlighted the need for a holistic, interdisciplinary approach to education that fosters environmental awareness, encourages sustainable agricultural practices, and prepares students to become proactive agents of change. The following key points synthesize the findings from the three studies examined:

The studies underscore the critical role of education in promoting sustainability. They advocate for incorporating environmental, socio-environmental, and sustainable perspectives into various disciplines, particularly in agricultural and rural development programs. This integration is essential for raising awareness about the Sustainable Development Goals (SDGs) and fostering a culture of sustainability among students.

An interdisciplinary approach to teaching sustainability is vital. By integrating topics such as environmental policies, conservation, and socio-environmental impacts across subjects like geography, biology, chemistry, history, and sociology, the curriculum can provide a comprehensive understanding of sustainability issues. This approach ensures that students appreciate the interconnectedness of environmental, social, and economic dimensions of sustainability.

While incorporating interdisciplinary themes into the curriculum is a critical first step, it is equally important to ensure the effective implementation of these themes within the educational framework (and maybe there it is where our pen caps are). Simply including sustainability and interdisciplinary concepts in course outlines is insufficient; educators must actively engage with these topics and integrate them into their teaching practices. This requires comprehensive teacher training, the development of innovative teaching methods, and the

creation of opportunities for practical, hands-on learning experiences. By ensuring that interdisciplinary themes are not just theoretical concepts but are actively taught and experienced, educational institutions can provide students with the skills and knowledge necessary to address complex sustainability challenges effectively.

The studies highlight the importance of equipping students with the knowledge and skills to understand climate dynamics, develop adaptive strategies, and advocate for evidence-based policies. Recognizing the human impact on climate change and the need for sustainable agricultural practices is crucial for future professionals in the agrarian sector.

Education is a powerful tool for empowerment, enabling students to become informed and responsible citizens. By fostering critical thinking, experiential learning, and community engagement, educational programs can empower students to take meaningful action towards sustainability and climate resilience. This involves not only theoretical knowledge but also practical, hands-on experiences that reinforce sustainable practices.

The studies identify common misconceptions and knowledge gaps among students regarding sustainability and climate change. Addressing these gaps through targeted educational initiatives is crucial for enhancing climate literacy and promoting sustainable behaviors. Dispelling myths about the natural variability of climate change and emphasizing the significant impact of human activities are necessary steps in this direction.

Effective sustainability education requires collaboration between educational institutions, policymakers, and communities. The studies advocate for partnerships that facilitate the sharing of knowledge and resources, fostering a supportive environment for sustainable development. Community outreach and involvement are essential components for achieving long-term sustainability goals.

The synthesis of these studies underscores a unified vision for sustainability education that integrates interdisciplinary learning, emphasizes the importance of climate change

awareness, and empowers students to advocate for and implement sustainable practices. By addressing knowledge gaps and fostering community engagement, educational institutions can play a pivotal role in shaping a more sustainable and resilient future.

These efforts are essential for preparing students to navigate the complex environmental, social, and economic challenges of the future, ultimately contributing to a more equitable and sustainable world. The commitment to sustainability education must remain a cornerstone in shaping the minds and values of young learners, empowering them to make meaningful contributions to society and the planet.

In conclusion, the findings from this research highlight the significant strides made in integrating sustainability into education while also pointing out the areas needing further improvement. By continuously refining educational strategies and fostering a collaborative approach, we can ensure that future professionals are well-equipped to drive sustainable development and address the global challenges that lie ahead.

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APPENDIX 1

THIS QUESTIONNAIRE AIMS TO UNDERSTAND THE STUDENTS' UNDERSTANDING OF SUSTAINABILITY IN THE AGRICULTURAL/AGRICULTURAL TECHNICAL COURSE AT CAET.

*Indicates a required question

1. **Free and Informed Consent Term. ***

I confirm that I understand the purpose of the questionnaire and agree that my responses may be used anonymously in this research. Check the box below if you agree, otherwise just close your browser.
Check all that apply.
I agree to participate.

2. **In which grade are you:**

2nd year
3rd year

3. **What is your state of origin? ***
4. **What is your city of origin? ***
5. **Currently, what is your housing situation? ***
   a. I stay in the College dormitory.
   b. I return to a rented house/apartment every day.
   c. I return to a family member's house every day.

Quick game - what do you think about this?
According to the scale:
Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

6. **The economic sectors that pollute the environment the most should be penalized accordingly. ***

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

7. **Climate change is an important global issue ***

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

8. **It is possible to increase agricultural production profits and preserve the environment at the same time. ***

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

9. **It is possible to reduce greenhouse gas emissions without reducing agricultural crop production. ***

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

10. **It is urgent that people reduce meat consumption. ***

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

11. **Other economic sectors pollute more than rural producers and should be penalized more. ***

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

12. **Agriculture is one of the main causes of global warming. ***

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

13. **Agriculture and livestock are greatly affected by global warming. ***

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

14. As an agricultural technician, I have an obligation to maximize agricultural production. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

15. The Brazilian government should encourage food production for export. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

16. The Brazilian government should encourage food production to meet national demands and overcome hunger and poverty. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

17. Climate change affects food prices. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

18. I believe that human-caused climate change is really happening. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

19. Rural production contributes to climate change. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

20. Climate change will affect agricultural production in the coming years. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

21. Climate change is already affecting agricultural production in my region. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

22. Climate change may represent more business opportunities than challenges in my region. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

23. Climate change will lead to lower agricultural production due to increased pests, diseases, prolonged droughts, and floods. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

24. Climate change mitigation strategies must necessarily bring economic gains to rural producers. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

25. Agricultural products with low greenhouse gas emissions should be sold at a higher price. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

26. The best climate change adaptation strategies are too expensive for rural producers to adopt. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

27. Rural producers should have the opportunity to increase their production regardless of environmental costs. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

28. Climate uncertainties resulting from climate change will negatively impact rural production. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

29. Climate change is a global problem, that is, agricultural management techniques do not have a significant impact. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

30. As an agricultural technician, I have an obligation to maintain or improve the rural environment for future generations. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

31. Climate change is real. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

32. I follow agro influencers on social media.

33. Rural producers are also responsible for global warming. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

34. Environmental regulations are important for the future of agricultural activity. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

35. The government should financially support rural producers in adapting to climate change. *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

36. What is climate change to you? *

37. Which agricultural activities generate the most greenhouse gases?

38. Which agricultural practices contribute the most to reducing greenhouse gas emissions?

39. Indicate how much each item is responsible for climate change.

	1. Not Responsible.	2. Slightly Responsible.	3. Very Responsible.
Industrial Processes to Produce Chemical Fertilizers:			
Burning fossil fuels.			
Precision agriculture.			
Destruction of forest areas.			
Animal production.			
Agricultural production.			

40. Indicate how much each item can reduce greenhouse gas emissions.

	1 Not Responsible.	2 Slightly Responsible	3 Very Responsible.
Use of Biological Nitrogen Fixation Microorganisms.			
Composting.			
No-till Farming.			
Crops for Biofuel Production.			
Waste Treatment.			
Use of Enzymes in Animal Feeding.			
Precisian Agriculture.			

ABOUT SUSTAINABILITY IN THE TECHNICAL COURSE:

41. I know the concept of SUSTAINABILITY and its importance for conserving the environment and existing natural resources. *
Mark only one.
Yes (1), No (2).

42. If the answer is YES, where did you first hear about the concept of SUSTAINABILITY? *

At home (1), At school (Up to 9th Grade) (2), At CAET (3), On television (4), On the internet (5).

43. If the answer is at CAET, it was through: *

Peers (1), Basic education teachers (2), Professional education teachers (3), Field technicians (4), Pedagogical team (5), Administration (6).

44. How would you define the term sustainability? *

45. Which form of class provides a greater understanding of sustainability? *

Mark only one oval.
1 Lecture (On the board, slide presentation, book, etc.)
2 Dialogic class
3 Seminar presentation
4 Practical classes
5 Active methodologies (Mind map, Flipped classroom, etc.)

46. Which subjects during the course draw the most attention to SUSTAINABILITY?

47. Are you able to define SUSTAINABLE AGRICULTURE? *

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

48. How would you define sustainable agriculture? *

49. What are the most sustainable agricultural practices used at CAET? *

Check all that may apply.
Integration of crops and livestock
Preservation of environmental protection areas
Elimination of chemical product use
Integrated pest and disease management
Soil cover and protection
No till system for vegetables
Mandala garden
Non-conventional food plants
Agricultural homeopathy
Silviculture
Agroforestry systems
Biodynamic agriculture
Agroecology
Organic agriculture
Biofuels
Composting
Agroindustrial utilization of agricultural by-products
Adding value to family farming products
Agroindustrialization of agricultural products

50. In which sectors do teachers most often conduct sustainable practical activities?

Check all that apply.
Agriculture
Fish Farming
Plant Production
Animal Production
Meat Agroindustry
Dairy Agroindustry
Plant-based Agroindustry
Horticulture
Rabbit Farming
Open Spaces around Buildings
Existing Gardens on Campus
Computer Lab
Biology Lab
Chemistry Lab
Anatomy Models Lab
Medicinal Herb Garden.

51. During the practical activities and classroom sessions, do teachers encourage the ideas of SUSTAINABILITY?

52. During the practical activities and classroom sessions, do teachers encourage the use of SUSTAINABLE AGRICULTURE as the main means of production?

53. Does CAET offer education associated with the ideas of SUSTAINABILITY and SUSTAINABLE AGRICULTURE?

54. If the answer is YES, why?

Check all that apply.
Due to the infrastructure.
Due to the teaching staff.
Due to the technical staff.
Due to the pedagogical staff.
Due to the administration.
Other:

55. What is your relationship with agriculture? Have you managed to apply any technique learned in school?

SDGs
In 2015, the United Nations (UN) proposed that its 193 member countries sign the 2030 Agenda, a global plan consisting of 17 goals (SDGs) and 169 targets for these countries to achieve sustainable development by 2030. This plan represents a milestone in the pursuit of a better world for this and future generations and sets out actions to end poverty, promote prosperity and well-being for all, protect the environment, and tackle climate change.

56. I follow social media profiles that address sustainable practices in agriculture.

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).
57. Sustainability is easy to achieve.

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).
58. Sustainability is everyone's responsibility.

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).
59. Using chemical fertilizers without observing soil analysis is sustainable.

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).
60. If everyone turns off the tap while brushing their teeth, we will save water.

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).
61. Using hydroelectric power is sustainable.

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).
62. Consumers should financially support farmers who produce sustainably.

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).
63. The government should financially support farmers who produce sustainably.

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).
64. Using solar panel energy is sustainable.

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).
65. What do you consider unsustainable practices in agriculture?

66. Lab-grown meat is a sustainable solution to reduce animal meat consumption.

Strongly Disagree (1), Disagree (2), Not sure (3), Agree (4).

67. Have you heard of the SDGs?

Mark only one oval.
1 No
2 Yes

68. About SDGs, how knowledgeable are you on the topic:

Never heard of the SDGs (1), Have heard of them but have no knowledge (2), Have some knowledge (3), Very knowledgeable (4).

69. **In your opinion, which organizations have the most responsibility in** implementing the Sustainable Development Goals in Brazil?

Mark only one oval..
Federal Government.
State Government.
Municipal Government.
Companies/Private Sector/Business Associations.
Universities/Academic Institutions/Research Centers.
Churches/Religious Temples.
International Organizations (e.g., UN, UNICEF, USAID, WWF, Greenpeace, etc.).
NGOs (Non-Governmental Organizations).
Social Investors (foundations/private institutes).
Unions/Professional Associations.
Population/People in General.
All of the above.
None of the above.
Don't know/Prefer not to answer.
Mark all that apply.

70. Which organizations should act on implementing the Sustainable Development Goals in Brazil?

Federal Government.
State Government.
Municipal Government.
Companies/Private Sector/Business Associations.
Universities/Academic Institutions/Research Centers.
Churches/Religious Temples.
International Organizations (e.g., UN, UNICEF, USAID, WWF, Greenpeace, etc.).
NGOs (Non-Governmental Organizations)..
Social Investors (foundations/private institutes).
Unions/Professional Associations.
Population/People in General.
All of the above.
None of these.
Don't know/Prefer not to answer.

71. Based on the following list of SDGs, which would bring benefits to Brazil if implemented?

SDG	1- Would bring no benefits	2- Would bring few benefits	3- Don't know/Prefer not to say	4- Would benefit.
No Poverty				
Zero Hunger and Sustainable Agriculture				
Good Health and Well-being				
Quality Education				
Gender Equality				
Clean Water and Sanitation				
Affordable and Clean Energy				
Decent Work and Economic Growth				
Industry, Innovation, and Infrastructure				
Reduced Inequalities				
Sustainable Cities and Communities				
Responsible Consumption and Production				
Climate Action				
Life Below Water				
Life on Land				
Peace, Justice, and Strong Institutions				
Partnerships for the Goals				

73. How can an agricultural or livestock technician contribute to the advancement of the SDGs?

ABOUT YOU

74. How old are you?

75. What is your gender?

Female.
Male.
Prefer not to say.

76. Which social media do you use?

TikTok
Instagram
Twitter/X
Discord
Facebook

77. Do you consider yourself from:

Rural areas (1), Urban areas (2), Both (3).

78. How many brothers or sisters do you have?

0 1 2 3 4 5 6 More than 7
Sisters (female)
Brothers (male)

79. What religious group do you identify with?

Mark only one oval.
Catholic
Evangelical
Protestant
Spiritist
Afro-Brazilian Religion
Atheist
None

80. How do you identify yourself?

Mark only one oval.
White
Black
Mixed Race
Indigenous
Other

81. Check all musical genres you like:

Rock
MPB
Traditional Sertanejo
University Sertanejo
Electronic
Bandinha (ballroom)
Classical Music
Forró
Samba
Pagode
Hip Hop
Rap
Reggae

Funk
Jazz
Gospel

82. During your leisure time, list up to three entertainment activities you usually practice:

83. In your understanding, how much does interaction with the following groups influence your personality/identity:

Group	None	Little	A lot	N/A
Family				
Friends				
Religious Spaces				
School				
Romantic Relationship				

84. How did you feel answering this questionnaire?

85. This space is open for you to make comments if you find it necessary and relevant.

APPENDIX 2

THIS QUESTIONNAIRE AIMS TO UNDERSTAND THE STUDENTS' UNDERSTANDING OF SUSTAINABILITY FOR ADVANCED STUDENTS

1. **Nationality:**
2. **Which state are you from:**
3. **In which city do you currently reside:**
4. **Do you currently consider that you reside in:**

Rural (1), Urban (2), Both (3)

SDGs

5. What does sustainability mean to you?
6. Have you heard about what the SDGs are?
7. Regarding the SDGs, what is your level of knowledge on the subject:

Never heard of the SDGs (1), Have heard of them but have no knowledge (2), Have some knowledge (3), Very knowledgeable (4).

8. In your opinion, which of these organizations would have the greatest responsibility in implementing the Sustainable Development Goals in Brazil?

Federal Government

State Government

Municipal Government

Companies/Private Sector/Business Associations

Universities/Academic Institutions/Research Centers

Churches/Religious Temples

International Organizations (e.g., UN, UNICEF, USAID, WWF, Greenpeace, etc.)

NGOs (Non-Governmental Organizations)

Social Investors (foundations/private institutes)

Unions/Professional Associations

Population/People in general

All of the above

None of these

Don't know/Prefer not to answer

9. Indicate which organizations should act in the implementation of the Sustainable Development Goals in Brazil?

Federal Government

State Government

Municipal Government

Companies/Private Sector/Business Associations

Universities/Academic Institutions/Research Centers

Churches/Religious Temples

International Organizations (e.g., UN, UNICEF, USAID, WWF, Greenpeace, etc.)

NGOs (Non-Governmental Organizations)

Social Investors (foundations/private institutes)

Unions/Professional Associations

Population/People in general

None of these

Don't know/Prefer not to answer.

10. From the following list of SDGs, which would bring benefits to Brazil if implemented?

SDG	1- Would bring no benefits	2- Would bring few benefits	3- Don't know/Prefer not to say	4- Would benefit.
No Poverty				
Zero Hunger and Sustainable Agriculture				
Good Health and Well-being				
Quality Education				
Gender Equality				
Clean Water and Sanitation				
Affordable and Clean Energy				
Decent Work and Economic Growth				
Industry, Innovation, and Infrastructure				
Reduced Inequalities				
Sustainable Cities and Communities				

Responsible Consumption and Production				
Climate Action				
Life Below Water				
Life on Land				
Peace, Justice, and Strong Institutions				
Partnerships for the Goals				

11. Evaluate the following statements and indicate your position:

	Disagree	Agree Partially	N/A	Totally agree
Sustainability is the responsibility of everyone				
If everyone closes the tap while brushing their teeth, we will save water				
Farmers are one of the main contributors to global warming				
There is no climate change, climate fluctuations have always happened				
Sustainability is easy				
Solar panels are sustainable				
Hydroelectrical power is sustainable				

12. How old are you?
13. What is your gender?
14. Do you fallow any religion?
15. How many people are there in your household?
16. What is your highest qualification?
17. What is your family income?

18. What is your opinion on the creation and execution of the SDGs?

APPENDIX 3

Correlation of the analyzed variables for agrarian technicians.

	KSDG	ASDG	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16	SDG17
KSDG	1,000	0,618	0,097	0,145	0,127	0,102	0,039	0,146	0,209	0,135	0,140	0,114	0,133	0,130	0,198	0,122	0,129	0,151	0,144
ASDG	0,618	1,000	0,008	-0,053	-0,030	-0,083	0,069	-0,015	-0,021	-0,107	-0,023	0,000	-0,003	-0,045	0,072	0,024	0,003	0,047	0,009
SDG1	0,097	0,008	1,000	0,565	0,523	0,468	0,425	0,427	0,462	0,487	0,434	0,534	0,441	0,484	0,431	0,390	0,500	0,569	0,450
SDG2	0,145	-0,053	0,565	1,000	0,627	0,641	0,315	0,639	0,612	0,607	0,583	0,611	0,610	0,631	0,542	0,459	0,487	0,518	0,652
SDG3	0,127	-0,030	0,523	0,627	1,000	0,719	0,252	0,726	0,775	0,660	0,639	0,570	0,698	0,740	0,627	0,371	0,553	0,523	0,706
SDG4	0,102	-0,083	0,468	0,641	0,719	1,000	0,222	0,759	0,737	0,740	0,592	0,556	0,627	0,681	0,565	0,378	0,588	0,545	0,681
SDG5	0,039	0,069	0,425	0,315	0,252	0,222	1,000	0,211	0,202	0,346	0,287	0,515	0,252	0,254	0,255	0,261	0,252	0,433	0,271
SDG6	0,146	-0,015	0,427	0,639	0,726	0,759	0,211	1,000	0,773	0,686	0,608	0,504	0,637	0,760	0,626	0,456	0,539	0,543	0,733
SDG7	0,209	-0,021	0,462	0,612	0,775	0,737	0,202	0,773	1,000	0,673	0,655	0,518	0,677	0,730	0,688	0,409	0,638	0,575	0,736
SDG8	0,135	-0,107	0,487	0,607	0,660	0,740	0,346	0,686	0,673	1,000	0,636	0,602	0,539	0,601	0,553	0,386	0,517	0,552	0,658
SDG9	0,140	-0,023	0,434	0,583	0,639	0,592	0,287	0,608	0,655	0,636	1,000	0,567	0,603	0,615	0,584	0,347	0,522	0,543	0,691
SDG10	0,114	0,000	0,534	0,611	0,570	0,556	0,515	0,504	0,518	0,602	0,567	1,000	0,500	0,548	0,469	0,352	0,451	0,666	0,577
SDG11	0,133	-0,003	0,441	0,610	0,698	0,627	0,252	0,637	0,677	0,539	0,603	0,500	1,000	0,705	0,605	0,353	0,485	0,512	0,675
SDG12	0,130	-0,045	0,484	0,631	0,740	0,681	0,254	0,760	0,730	0,601	0,615	0,548	0,705	1,000	0,625	0,389	0,476	0,577	0,684
SDG13	0,198	0,072	0,431	0,542	0,627	0,565	0,255	0,626	0,688	0,553	0,584	0,469	0,605	0,625	1,000	0,433	0,524	0,532	0,609
SDG14	0,122	0,024	0,390	0,459	0,371	0,378	0,261	0,456	0,409	0,386	0,347	0,352	0,353	0,389	0,433	1,000	0,585	0,430	0,422
SDG15	0,129	0,003	0,500	0,487	0,553	0,588	0,252	0,539	0,638	0,517	0,522	0,451	0,485	0,476	0,524	0,585	1,000	0,629	0,558
SDG16	0,151	0,047	0,569	0,518	0,523	0,545	0,433	0,543	0,575	0,552	0,543	0,666	0,512	0,577	0,532	0,430	0,629	1,000	0,600
SDG17	0,144	0,009	0,450	0,652	0,706	0,681	0,271	0,733	0,736	0,658	0,691	0,577	0,675	0,684	0,609	0,422	0,558	0,600	1,000

Source: The Authors (2024)

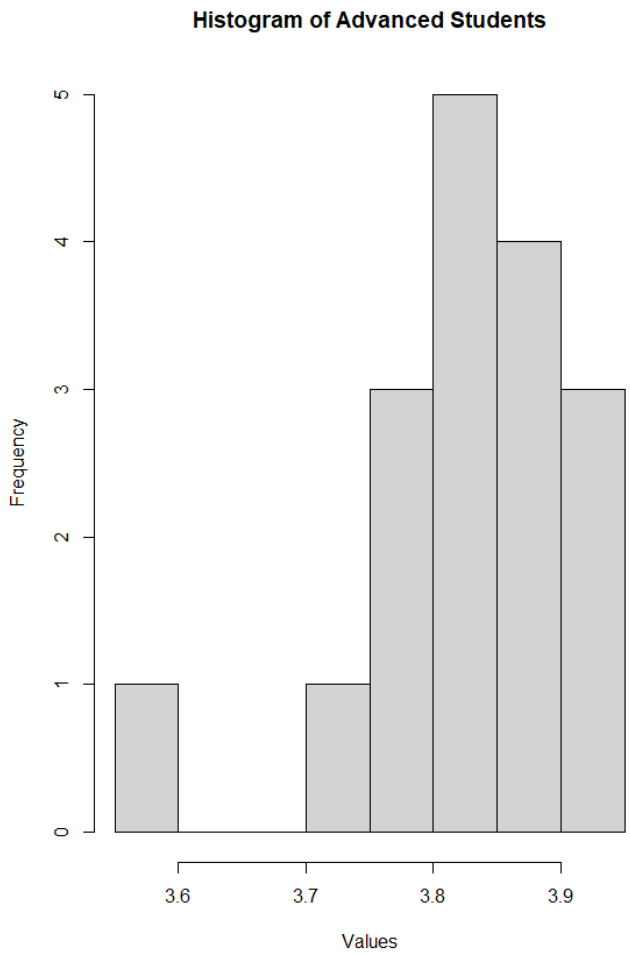
APPENDIX 4

Correlation of the analyzed variables for advanced students.

	KSDG	ASDG	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16	SDG17
KSDG	1,000	0,701	0,027	-0,051	-0,073	0,002	0,083	-0,054	-0,079	-0,044	0,041	0,064	-0,063	-0,076	0,034	-0,014	0,001	0,046	-0,001
ASDG	0,701	1,000	0,051	-0,052	-0,075	0,012	0,123	-0,105	-0,060	0,017	0,008	0,063	-0,100	-0,045	-0,024	0,047	0,073	0,061	-0,013
SDG1	0,027	0,051	1,000	0,668	0,629	0,720	0,532	0,555	0,445	0,556	0,325	0,778	0,454	0,530	0,410	0,399	0,428	0,573	0,400
SDG2	-0,051	-0,052	0,668	1,000	0,695	0,617	0,388	0,798	0,656	0,529	0,478	0,557	0,663	0,688	0,617	0,470	0,499	0,380	0,362
SDG3	-0,073	-0,075	0,629	0,695	1,000	0,590	0,356	0,707	0,608	0,528	0,395	0,466	0,566	0,587	0,415	0,390	0,417	0,305	0,348
SDG4	0,002	0,012	0,720	0,617	0,590	1,000	0,469	0,533	0,492	0,486	0,491	0,630	0,428	0,451	0,455	0,498	0,475	0,510	0,397
SDG5	0,083	0,123	0,532	0,388	0,356	0,469	1,000	0,323	0,349	0,446	0,309	0,540	0,347	0,399	0,460	0,396	0,432	0,577	0,376
SDG6	-0,054	-0,105	0,555	0,798	0,707	0,533	0,323	1,000	0,666	0,456	0,406	0,454	0,654	0,679	0,557	0,462	0,491	0,346	0,355
SDG7	-0,079	-0,060	0,445	0,656	0,608	0,492	0,349	0,666	1,000	0,580	0,507	0,396	0,608	0,519	0,499	0,501	0,477	0,345	0,327
SDG8	-0,044	0,017	0,556	0,529	0,528	0,486	0,446	0,456	0,580	1,000	0,594	0,487	0,363	0,407	0,479	0,466	0,549	0,479	0,338
SDG9	0,041	0,008	0,325	0,478	0,395	0,491	0,309	0,406	0,507	0,594	1,000	0,320	0,377	0,376	0,413	0,401	0,373	0,385	0,352
SDG10	0,064	0,063	0,778	0,557	0,466	0,630	0,540	0,454	0,396	0,487	0,320	1,000	0,527	0,612	0,494	0,459	0,540	0,715	0,511
SDG11	-0,063	-0,100	0,454	0,663	0,566	0,428	0,347	0,654	0,608	0,363	0,377	0,527	1,000	0,817	0,521	0,447	0,475	0,330	0,476
SDG12	-0,076	-0,045	0,530	0,688	0,587	0,451	0,399	0,679	0,519	0,407	0,376	0,612	0,817	1,000	0,574	0,488	0,551	0,451	0,522
SDG13	0,034	-0,024	0,410	0,617	0,415	0,455	0,460	0,557	0,499	0,479	0,413	0,494	0,521	0,574	1,000	0,493	0,579	0,418	0,372
SDG14	-0,014	0,047	0,399	0,470	0,390	0,498	0,396	0,462	0,501	0,466	0,401	0,459	0,447	0,488	0,493	1,000	0,882	0,528	0,405
SDG15	0,001	0,073	0,428	0,499	0,417	0,475	0,432	0,491	0,477	0,549	0,373	0,540	0,475	0,551	0,579	0,882	1,000	0,607	0,437
SDG16	0,046	0,061	0,573	0,380	0,305	0,510	0,577	0,346	0,345	0,479	0,385	0,715	0,330	0,451	0,418	0,528	0,607	1,000	0,642
SDG17	-0,001	-0,013	0,400	0,362	0,348	0,397	0,376	0,355	0,327	0,338	0,352	0,511	0,476	0,522	0,372	0,405	0,437	0,642	1,000

Source: The Authors (2024)

APPENDIX 5


Histogram of Advanced Students
Frequency
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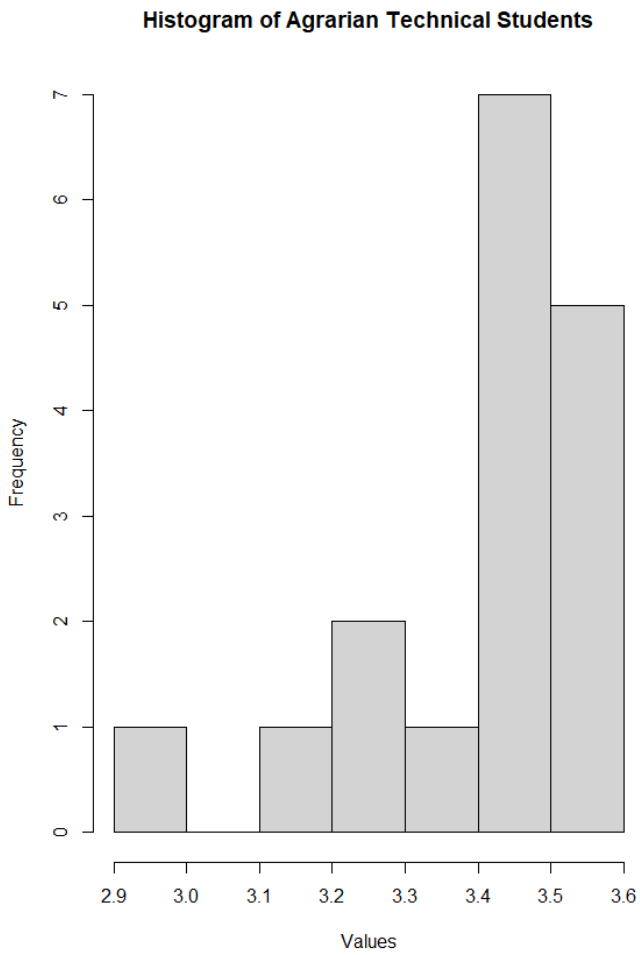
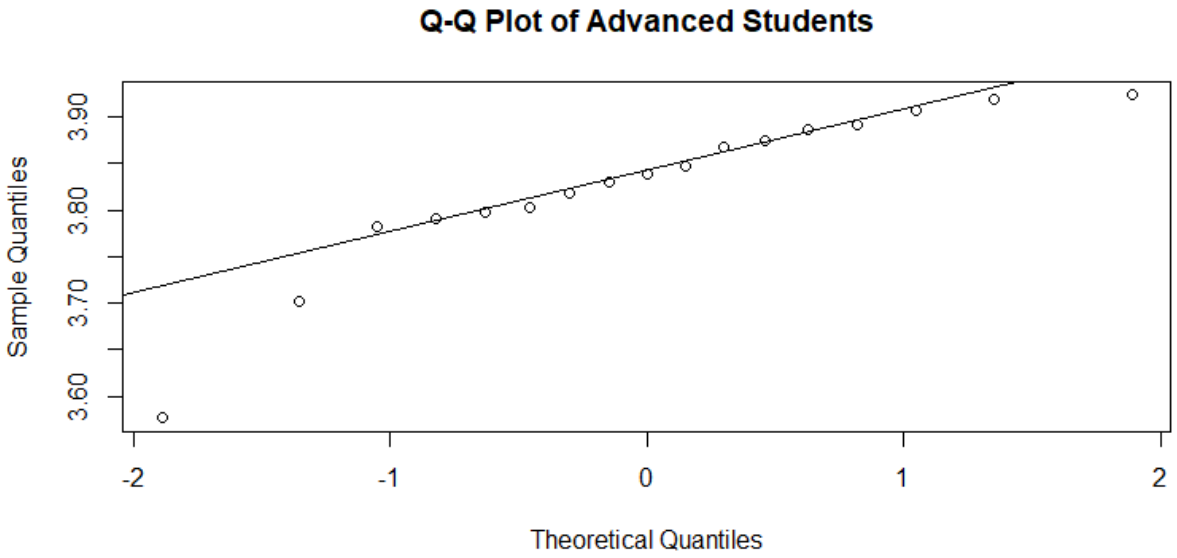
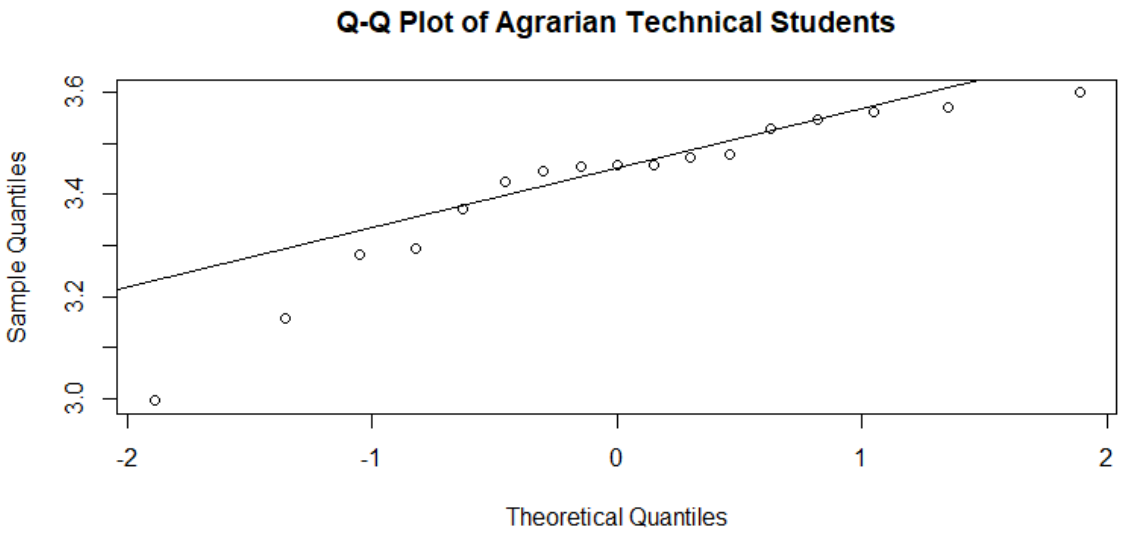
1
2
3
4
5
3.6
3.7
3.8
3.9
Values


Histogram of Agrarian Technical Students
Frequency
0
1
2
3
4
5
6
7
2.9
3.0
3.1
3.2
3.3
3.4
3.5
3.6
Values



Source: The Authors, 2024.


Q-Q Plot of Agrarian Technical Students
Sample Quantiles
3.0
3.2
3.4
3.6
-2
-1
0
1
2
Theoretical Quantiles