frontiers | Frontiers in Sustainable Food Systems

TYPE Original Research
PUBLISHED 15 May 2024
DOI 10.3389/fsufs.2024.1399663

OPEN ACCESS

EDITED BY
Moslem Savari,
Khuzestan University of Agricultural Sciences and Natural Resources, Iran

REVIEWED BY
Naser Valizadeh,
Shiraz University, Iran
Amir Naeimi,
University of Zanjan, Iran

*CORRESPONDENCE
Mehrdad Niknami
✉ Mehrdad.niknami@iau.ac.ir

RECEIVED 12 March 2024
ACCEPTED 01 May 2024
PUBLISHED 15 May 2024

CITATION
Jomegi M, Niknami M, Sabouri MS and Bijani M (2024) Challenges of implementing a climate-smart agriculture-based curriculum in agricultural vocational schools: evidence from Iran.
Front. Sustain. Food Syst. 8:1399663.
doi: 10.3389/fsufs.2024.1399663

Challenges of implementing a climate-smart agriculture-based curriculum in agricultural vocational schools: evidence from Iran

Mehdi Jomegi[1], Mehrdad Niknami[1*], Mohammad Sadegh Sabouri[1] and Masoud Bijani[2]

[1]Department of Agricultural Extension and Education, Garmsar Branch, Islamic Azad University, Garmsar, Iran, [2]Department of Agricultural Extension and Education, College of Agriculture, Tarbiat Modares University, Tehran, Iran

The research aimed to identify the challenges of developing and implementing a climate-smart agriculture (CSA)-based curriculum in Iran's agricultural vocational schools. It was exploratory descriptive-analytical in nature and applied in goal, in which data were collected with the library and deep interview method. The research methodology was based on grounded theory. The statistical population was composed of 16 researchers, authors, managers, and experts of the Office of Textbook Compilation of the Organization for Educational Research and Planning and the Research Center of Educational Studies. The participants were selected by the homogenous purposive sampling method. The interview with the target population continued until it reached theoretical saturation. Data were analyzed using the content analysis method. The data collected in the interviews were subjected to open, axial, and selective coding, which resulted in deriving 119 concepts and 28 categories. The results revealed a seven-dimension structure composed of the challenges related to determining educational goals, trainees, trainers' professional process, teaching methods, curriculum content selection and organization, curriculum implementation, and curriculum appraisal. The results can help the experts in the Office of Textbook Compilation experts adopt smarter policies and solutions to solve the challenges of developing and implementing a CSA-based curriculum in agricultural vocational schools in Iran.

KEYWORDS

agricultural vocational schools, agriculture training, climate change, climate-smart agriculture, curriculum

1 Introduction

Sustainable development goals (SDGs) require global society to be committed to eradicating poverty, ending hunger, and taking urgent action to cope with climate change and its effects by 2030 (Tadesse and Ahmed, 2023). On the other hand, agriculture is the most critical factor determining the achievement of these goals (Fentie and Beyene, 2019). It is, however, one of the most susceptible sectors to the effects of climate change due to its inherent risks and uncertainties (Pacillo et al., 2022). These risks have mostly a climatic component, and they are all influenced in some way by climate change in severity, range, or frequency (Gebru et al., 2020). Climate change can pose risks to farming and livelihood, so it is imperative to adopt measures to alleviate the risks and grasp the opportunities (Partey et al., 2018). In this regard, climate-smart agriculture (CSA) has been presented as a new paradigm for adapting agriculture to climate change (Khatri-Chhetri et al., 2020). CSA is a strategy to manage agriculture in the face of climate change, which can increase farmers' productivity, adaptability, and resilience against climate change (Fentie and Beyene, 2019; Tavassoti et al., 2021). This approach tries to minimize the losses caused by climate change (Khatri-Chhetri et al., 2020).

When facing a climatic crisis, it is necessary to ask what role the youth and teenagers' education plays in improving adaptation to climate change (Kumar et al., 2023). Since agriculture is a jumping stage of all advanced economies toward sustainable development (Coulibaly et al., 2021), smart climate-consistent planning in the agricultural education sector is crucial, and national economic and food security will incur irreparable losses if ignored. Therefore, it is suitable to provide adolescents and youth with education to initiate implementing environmental protection programs (Agus and Ali, 2022). In this respect, agricultural vocational schools are vital in fostering creative, determined, and innovative human resources for coping with and adapting to climate change (Jomegi and Lashgarara, 2013).

A priority for CSA development in Iran is to develop a CSA-based curriculum for the textbooks of the agricultural education system, especially agricultural vocational schools (Belay et al., 2022). Textbooks are designed to convey knowledge and certain ideas to students and to transfer what is perceived as important by older generations (Gokmenoglu et al., 2023). According to scholars, curricula are the heart of any educational system, so the efficiency of any educational system depends on the efficiency of curricula (Simanjuntak et al., 2022). Curricula focus on students' perception of society and their beliefs regarding their importance to teachers (Morote et al., 2020). They bring order to classes and help students be more organized when engaging in school activities (Campbell-Phillips, 2020).

Curriculum management plays an essential role in the development of the content taught by the teacher and learned by the students, so curriculum can be a catalyst for change (Wahyudi et al., 2020). Evidence shows that the educational system has considered CSA inadequately, and there are some barriers. Karmi et al. (2019) argue that in the context of climate change, public efforts in all disciplines are required to cope with and adapt to this phenomenon. On the other hand, most activities in this regard have concentrated on hardware and technology with much less attention to the software and learning to protect the Earth. Berhanu et al. (2024) revealed that educational programs and farm visits positively influenced CSA-adopting smallholders' resilience. Jomegi et al. (2023) argue that there is a positive relationship between climate-smart practices and such factors as farmers' knowledge and skill. Chauhan et al. (2022) found that CSA must be included in curricula as an integrated approach to achieving agriculture sustainability. Chetti et al. (2022) explain that the Indian government has launched various programs for the sustainable development of agriculture, one of which is to promote skills among agriculture graduates through ICT and the introduction of CSA at schools. Ahmed et al. (2022) report that since agriculture is mostly rain-fed in Nigeria, a CSA-based curriculum must be developed for the youth who will guide agricultural activities in the near future. Handayani (2021) argues that the understanding of climate change dynamism is critical for supporting farmers' adaptation to future conditions. Nonetheless, students and graduates do not understand the concept and application of climate change in light of the dynamism of food production and future food security, whereas agriculture is faced with the challenge of climate change adaptation. According to Koirala and Bhandari (2020), the adoption and use of CSA technologies can be accelerated by establishing a link among animal farmers, researchers, and agricultural extension and education experts. Also, it should be ensured that CSA activities are implemented with a decentralized perspective on curricula.

The problems of educational systems, especially agricultural vocational schools, originate from the lack of information available to planners on optimal standards for agriculture education. Also, the insufficiencies and bottlenecks of agricultural vocational schools in training skillful human resources are rooted in how they offer practical and skill courses. A review of the history of this education in Iran shows the weaknesses in the scientific and practical bodies of education in agricultural vocational schools, especially in curriculum and inattention to CSA. This issue can be solved if agricultural vocational schools pursue a modern orientation in curricula (Pormoid and Yazdakhasi, 2021). To solve this problem, agricultural vocational schools must follow a new orientation in their curricula. The central theme of this research is the educational requirements of agricultural vocational schools across Iran in terms of the curriculum and attention to planning for CSA so educational planners can reinforce agricultural training in this field (Waaswa et al., 2021). Also, research in Iran shows that no proper research has addressed climate change education in the educational system so far (Taghibaygi and Khosravipour, 2020), and there are problems in the scientific and practical body of education in agricultural vocational schools. On the other hand, the development of CSA-based curricula has yet to be investigated in Iran. Hence, the education of climate change and the development of a curriculum for CSA as a branch of environmental education has been neglected and overlooked in Iran, although it has been a challenge in recent years. Thus, the research gap in this domain is quite evident. Therefore, this is the first study in Iran that deals with the challenges of implementing a CSA-based curriculum in agricultural vocational schools, and it is expected to speed up the adoption of CSA first by trainers and trainees and then by farmers (Waaswa et al., 2021). In this concern, revising and updating curricula and solving their challenges as per the issue of climate change, diverse developments and innovations in the context of information sharing, economic developments, knowledge-based economy, more attention to experts, and social developments can help curricula to orient with meeting the needs of society.

Seemingly, CSA-based curricula are implemented in Iran's agricultural vocational schools more slowly than in other parts of the world. However, research in this respect has been limited, and this limited research has still focused on the results of the programs in the short run, whereas vast developments have happened at the school level in various parts of the world (Moradi and Didehban, 2017). Accordingly, having an up-to-date curriculum with a systematic and climate change-consistent approach is inevitable for the educational system at agricultural vocational schools. The application of the paradigm proposed in this research can be effective in implementing CSA-based curricula at agricultural vocational schools.

Considering the problems and challenges of designing and implementing curricula in agricultural vocational schools, this institution obviously needs its challenges and obstacles identified and solved more than ever. In this regard, the present research aimed to analyze the challenges of formulating and implementing a CSA-based curriculum in agricultural vocational schools. Since the theoretical basis is poor in this regard, but the issue is of crucial significance, we tried to explore the issues, problems, and bottlenecks of developing and implementing a CSA-based curriculum in Iran's agricultural vocational schools scientifically and closely in order to propose key solutions and strategies, thereby leaping toward designing such curriculum for these schools in Iran.

2 Research methodology

The research was an applied study in goal and an explorative study in research approach, and a quantitative study in research type, which used grounded theory as its method. Data were collected by interview. The document method was used to develop the theoretical framework, and a field survey was adopted to detect the challenges of developing and implementing a CSA-based curriculum for Iran's agricultural vocational schools. Data were collected by both the library and field methods. So, after the literature on curricula and CSA including the textbooks of 10th, 11th, and 12th grades, such as basic technical knowledge of horticulture, basic technical knowledge of animal farming, basic technical knowledge of crop farming, basic technical knowledge of agricultural machinery, the application of modern technologies, technical and professional knowledge of cropping, and crop cultivation was reviewed, the main challenges and deterrents were derived and used to compile the initial questionnaire. Thus, the research tried to answer the question with a qualitative approach. The research was based on the systematic grounded theory methodology. The sampling was non-random. The data analyst decided to select the next sample during theory formation as long as the theory was finalized. In grounded theory, the sample size is not known in advance, and sampling continues during data analysis until the theory reaches theoretical saturation (Corbin and Strauss, 2012). The statistical population comprised researchers, authors, managers, and experts at the Office of Textbook Compilation of the Organization for Educational Research and Planning and at the Research Center of Educational Studies. The sample was taken using the snowball technique purposively, and sampling continued until theoretical saturation for which 16 experts were selected.

The statistical population was selected according to Jomegi et al. (2023) procedure. According to them, the theory in a qualitative study is valid if the researcher has reached the saturation point. To achieve this point, the field study must continue until no new evidence is obtained from the data. In other words, the data has wholly been revised. The theoretical saturation point reflects the validity of the grounded theory method because the theoretical saturation point deals with data replication. This replication and its results in methodology show the reliability of the research method. It was tried to ensure data validity by integrating data collection methods (personal interview and observation), combining data sources (researchers, authors, managers, and experts of the Office of Textbook Compilation), and maximizing sample diversity (in terms of interviews with people at different levels including researchers, authors, managers, and experts of the Office of Textbook Compilation). The researchers did not involve their assumptions during data collection, analysis, and interpretation as much as possible. To take care of data transferability, the researchers who had participated in interviews and noted all questions and answers revised the findings. The participants were asked about the challenges of developing and implementing a CSA-based curriculum in Iran's agricultural vocational schools, which are reported in detail in the Results section. Validity in qualitative research comprises internal validity and external validity. The interval validity (consistency of the research findings with reality) was measured using the remarks and recommendations of the supervisors and advisers, researchers, long-term observations, engagement of participants in all research steps, and the formulation of research biases. The external validity (applicability or generalizability of the research findings to other situations) was also measured by an in-depth description of data collected through the interviews. The coding reliability was determined by triangulation through data consensus (using different sources from different groups at different times), researchers consensus (revising the findings by using the opinions of several researchers), and consensus of methods (using severing methods, such as observation, interview, documents, and questionnaire). Data were analyzed concurrently with data collection through three steps open coding, axial coding, and selective coding, for which $MAXQDA_{12}$ was used.

2.1 Step 1: open coding

This step of the grounded theory method immediately follows the first interview. After each interview, the researcher focuses on finding concepts, picking proper labels for them, and combining similar concepts. The open coding steps are as follows:

- Analysis and coding: In this step, the researcher should consider coding all events. A lot of codes may be derived from an interview or a text. But, when data are regularly revised, new codes are counted, and final codes are specified.
- Open coding table: It is composed of two parts. One is the table of the initial codes derived from the interviews, and the next is the table of categories derived from the codes, as well as their conceptual codes.

2.2 Step 2: axial coding

In the second step of coding, axial coding, the researcher selects a category as the core category, explores it as the core phenomenon, and specifies the relationships of other categories with it. These relationships can be of five types (Corbin and Strauss, 2012):

- Causal conditions: These conditions contribute to the formation of the core phenomenon or category formation. These conditions are a set of categories and their characteristics that influence the main category.
- Strategies (actions and interactions): They express the behaviors, facts, and purposeful interactions that influence intervening and governing conditions.

- Contextual factors: They refer to specific conditions that influence strategies, and it is difficult to distinguish them from causal conditions. These conditions are composed of concepts, categories, and contextual variables. There is a set of active variables against causal conditions. Highly relevant variables are sometimes categorized under causal conditions, while lowly relevant ones are categorized under governing conditions.
- Intervening conditions: These are conditions that affect strategies. These conditions are composed of a set of intervening variables. Intervening conditions are the structural conditions that facilitate or limit the intervention of other factors and have a causal and general nature.
- Consequences: Some categories reflect the consequences and results of adopting the strategies. This coding method, which is called the axial coding paradigm, was proposed by Corbin and Strauss (2012). It is called *axial* because coding is around the axis of a single category.

2.3 Step 3: selective coding

This step includes selecting a core category regularly and systematically, validating the relations, and filling the gaps with categories that need revisions and expansion. This step is composed of some sub-steps. The first sub-step is to explain the main storyline. The second is to relate the supplementary categories to the core category using a paradigm (as described in the axial coding). The third is to relate the categories to one another at the dimensional level. The fourth is to confirm their relationships in the light of data. The last is to complete the categories that need revision or expansion (Danai Fard and Eslami, 2021).

3 Results

This research conducted deep interviews with 16 researchers, authors, managers, and experts at the Office of Textbook Compilation of the Organization for Educational Research and Planning and the Research Center of Educational Studies. The research ethics requires that we maintain their anonymity.

The results of the demographic characteristics revealed that 15.4% of the participants had career experience of <5 years, 30.8% had career experience of 6–10 years, and 53.8% had career experience of >10 years. It was also found that 69.2% were university teachers, and 30.8% were managers and experts at the Office of Textbook Compilation of the Organization for Educational Research and Planning and the Research Center of Educational Studies. Females constituted 39.8%, and males constituted 69.2% of the participants.

After collecting data from interviews and texts, they were subjected to analysis and coding in three stages: open, axial, and selective coding. In open coding, the compatibility between the homogeneity of the data and the categories derived was checked with regard to the information collected from the interviews. Then, in axial coding, the categories derived from open coding were recombined as a paradigm model based on Corbin and Strauss's approach, including causal conditions, contextual conditions, intervening factors, strategies, and consequences, in order to provide a more precise and rational picture of the findings. Finally, selective coding was performed to reach the core category. The output of selective coding is the paradigm model and the basic theory. Based on the interviews, redundant and unrelated items were discarded, and the items that were repeated the most in the interviews were extracted.

3.1 Causal conditions underpinning the development of CSA-oriented content for the curriculum of agricultural vocational schools

Motivational conditions, or the so-called "causal factors," are the conditions and events that contribute to the realization and formation of a CSA-based curriculum with their occurrence. In fact, motivational conditions and factors answer the question as to the reasons and causes of curriculum development. The causal conditions that influence the realization and formation of a CSA-based curriculum and were derived by the researcher from the interviews are centralized curriculum development, poor facilities and equipment for curriculum implementation, lack of educational needs analysis, and passive teaching methods (Table 1).

3.2 Contextual conditions underpinning the development of CSA-oriented content for the curriculum of agricultural vocational schools

In general, *contextual conditions* represent specific attributes that typically influence general strategies. In other words, they are the place of the events related to the core phenomenon. These conditions in the present research include non-interactive educational content, weakness in skill-oriented educational content, weakness in content updating, traditional teaching, weakness in promoting analytical skills, weakness in trainees' effective learning, and learning inefficiency (Table 2).

3.3 Intervening conditions underpinning the development of CSA-oriented content for the curriculum of agricultural vocational schools

Contingent factors called "intervening conditions" are general and broader conditions, e.g., time, place, and culture, that influence the main strategies. The nature of these elements is such that response to them depends on the success and situation. These factors are the most influential on macro strategies. Owing to their nature, they change over time. The intervening conditions derived in this research include improper teaching, lack of teaching diversity, lack of exploratory teaching, weakness in strengthening problem-solving skills, poor visual content, poor textual content, and poor fitness of evaluation methods with educational goals (Table 3).

3.4 Strategies underpinning the development of CSA-oriented content for the curriculum of agricultural vocational schools

"Strategy," as strategic and systemic factors, refers to how a core phenomenon is controlled and dealt with in certain conditions. In

10.3389/fsufs.2024.1399663

TABLE 1 The concepts and categories identified the causal conditions that influence CSA-oriented content development for the curriculum of agricultural vocational schools.

Selective code	Axial code	Concept (initial code)	Frequency
Causal conditions	Centralized curriculum development	• Faint belief in the importance of curriculum planning in education	4
		• Ignorance of the importance of curriculum planning regarding CSA	5
		• Weakness in reviewing and revising curricula	2
		• Insufficient flexibility in the curriculum	1
		• Weakness in accepting changes in the underlying philosophy and concepts of education	6
		• Bureaucracy in the Ministry and Curriculum Development Council	5
	Poor facilities and equipment for curriculum implementation	• Lack of scientific equipment and facilities in schools regarding CSA	2
		• Inadequate use of curriculum specialists	2
		• Lack of proper infrastructure for professional and skill training	4
	Lack of educational needs analysis	• Weakness in revising the curriculum according to the evolution of trainees' needs	2
		• Poor ability of educational planners to respond to the needs of society	5
		• Weakness in needs assessment for developing, revising, or changing the curriculum regarding CSA	4
	Passive teaching methods	• Uniformity of teaching methods instead of diversity	6
		• Weakness of holding educational and practical workshops	2
		• Weakness in using active learning methods	5
		• Superficial learning and not paying attention to deep learning	4
		• Weakness in the compatibility of teaching methods with a lifelong learning approach	2
		• The weakness of students in the ability to change the teaching method	1
		• Poor compatibility of the teaching methods with the content	3

TABLE 2 The concepts and categories identified about the contextual conditions that influence CSA-oriented content development for the curriculum of agricultural vocational schools.

Selective code	Axial code	Concept (initial code)	Frequency
Contextual conditions	Non-interactive educational content	• Poor organization of available scientific resources by CSA experts	3
		• Weakness in interaction and cooperation of CSA book publishers	1
		• Faint belief in the importance of curricula among research committee members	2
		• Poor cooperation of academic faculty members in compiling CSA books	4
	Weakness in skill-oriented educational content	• Weakness in developing learning opportunities	2
		• Poor fitness in practical and theoretical courses	1
		• Impracticality of training content	3
		• Poor balance between textbooks and labor market requirements	5
		• Weakness in paying attention to fostering talents in educational content	4
	Weakness in content updating	• Lack of practical materials about the climate of different regions in the curriculum	5
		• Low attractiveness, practicality, and up datedness of the curriculum	7
		• Low familiarity of developers with curriculum knowledge	2
		• The gap between the curriculum and the modern knowledge	2
		• Weakness in curriculum revision by experts	4
	Traditional teaching	• The use of outdated and traditional methods in teaching	3
		• Weakness in practical training and model farm visits	5
		• More attention to theory than to practice in learning	5
		• Relying on pamphlets and old educational resources	4
	Weakness in promoting analytical skills	• Weakness in proper understanding of the CSA curriculum	6
		• Inattention to research in the field of CSA	5
	Weakness in trainees' effective learning	• Weakness in improving students' learning skills	2
		• Weakness in improving trainees' motivation and interest in CSA	4
		• Poor quality of learning in education	2
		• Inattention to making trainees familiar with the most recent scientific materials	3
		• Weakness in paying attention to creative trainees in curriculum development	6
	Learning inefficiency	• Inattention to trainees' entry into the labor market	4
		• Weakness in engaging students in the learning environment	6

fact, this part of the research is related to presenting practical strategies with theoretical approaches, which, if the causal, contextual, and intervening conditions are considered adequately, can greatly contribute to developing and implementing a curriculum in the long run. This approach influences all the functions and actions of the Education Organization and pursues efficiency and effectiveness by applying all the skills and aligning the environmental conditions. The strategy in this research is to pay attention to performance goals, executive (behavioral) goals, and approach goals in education (Table 4).

3.5 Consequences of the development of CSA-oriented content for the curriculum of agricultural vocational schools

Other results are the "consequences" of the core phenomenon. These consequences are indeed actions and reactions that occur to deal with or manage and control the core phenomenon. The consequences in this research included promoting trainers' professional skills, improving personal abilities, using new methods in teaching, and evaluating trainees' ability to use CSA (Table 5).

Finally, the paradigm of the challenges of developing and implementing a CSA-based curriculum for agricultural vocational schools in Iran was extracted based on Corbin and Strauss' approach. It is displayed in Figure 1.

4 Discussion

Considering climate change and climatic crises worldwide (Romanello et al., 2022), the primary strategy to deal with climate change implications is to spread and apply CSA practices (Alliagbor et al., 2021). In this regard, planning in accordance with CSA is crucial in the education sector, whose ignorance will impose irreparable damage to Iran's economy and people's food security. So, appropriate education must be provided to start implementing environmental protection programs (Agus and Ali, 2022). Since trainees' activities in

TABLE 3 The concepts and categories identified about the intervening conditions that influence CSA-oriented content development for the curriculum of agricultural vocational schools.

Selective code	Axial code	Concepts (initial codes)	Frequency
Intervening conditions	Improper teaching	• Trainers' unfamiliarity with the skills and attitudes needed for using active teaching methods	3
		• Trainers' poor attention to the predetermined educational goals	4
		• Trainers' insufficient command of the content of CSA courses	2
	Lack of teaching diversity	• Trainers' unwillingness to teach CSA	5
		• Trainers' lack of creativity in teaching	2
		• Trainers' insufficient command of different teaching methods	3
		• Trainers' inattention to using other resources besides textbooks	4
	Lack of exploratory teaching	• Lack of creativity in designing questions and problems in teaching	4
		• Weakness in using integrated training	6
	Weakness in strengthening problem-solving skills	• Inattention to institutionalizing creativity and critical thinking in trainees	5
		• Trainees' passive participation in CSA teaching and learning	1
	Poor visual content	• Repetitive and irrelevant photos in textbooks	3
		• The use of archival images	4
		• Lack of using up-to-date photos	2
	Poor textual content	• Lack of diversity in content	5
		• Poor flexibility in the content of courses	6
		• Lower emphasis on content quality than on its quantity	1
		• Content produced beyond trainees' understanding and learning ability	2
		• Lack of up-to-date curriculum content in line with global developments	5
		• Inattention to sustainable agriculture in teaching resources	2
		• Identical and predetermined content	4
		• Lack of content fitness with the needs and conditions of society	2
		• Unfitness of textbooks with CSA	5
		• Copying and departure from the indigenous knowledge and culture of the country	3
		• Repetitive and boring content in textbooks	5
		• Inattention to CSA-related topics	2
		• Poor fitness of teaching methods with course content	4
		• Poor fitness of the content of textbooks with the theoretical foundations of CSA	3
	Poor fitness of evaluation methods with educational goals	• Non-use of diverse evaluation methods in the learning process	2
		• Weakness in the alignment of education, teaching, and evaluation	5

technical and vocational schools and agricultural vocational schools require diverse climate change-compatible training (Derbile et al., 2022) and the type of programs in formal education has not been considered adequately, the present research focused on exploring and analyzing the challenges of developing and implementing CSA-based curriculum in Iran's agricultural vocational schools. To help scholars to identify the challenges, the results have also been compared with relevant research. The results of coding the interviews and analyzing the findings in the qualitative phase prove it. The paradigm derived in the research specifies not only the conditions underpinning the implementation of a CSA-based curriculum, which includes causal, intervening, and contextual conditions, but also strategies and consequences. The results are as follows:

With a focus on the challenges of developing and implementing a CSA-based curriculum (the core phenomenon), the interviewees described its nature and reasons. Also, the philosophy and premise mentioned by the respondents in this description and in expressing their opinions and experiences mainly pointed to the key components and categories influencing curriculum implementation, which is an important phenomenon that can be a response to curriculum development. This research identified the challenges of implementing a CSA-based curriculum as the core phenomenon. It should be noted that agricultural education systems can prepare students to deal with fluctuations and uncertainties caused by climate change, propose solutions for coping with the growing risks of this phenomenon, and mitigate the adverse consequences of climate change. This support is essential, especially in Iran's conditions. On the other hand, the challenges of curriculum, especially the CSA-based curriculum, in responding to climate change can aggravate environmental and social losses. Thus, the educational system should be alerted to respond to

TABLE 4 The concepts and categories identified about the strategies that influence CSA-oriented content development for the curriculum of agricultural vocational schools.

Selective code	Axial code	Concepts (initial codes)	Frequency
Strategies	Pay attention to performance goals	• Efforts to increase trainees' optimal learning and achievement	3
		• Improving trainers' information literacy regarding CSA	2
		• Acquainting trainers with modern technologies regarding CSA	3
		• Creating deep learning opportunities	2
		• Strengthening participation in group discussions on CSA	2
	Paying attention to executive (behavioral) goals	• Institutionalizing creativity	4
		• Strengthening problem-solving skills in trainees	3
		• Considering the interests and needs of trainees in setting educational goals	2
		• Creating behavior change in trainees in the application of CSA	5
		• Promoting the skill of independence in learning	4
		• Considering the teaching and learning of CSA contents	3
		• Helping the development of creative thinking in trainees regarding CSA	2
	Paying attention to approach goals in education	• Fitting content with educational goals	4
		• Synchronizing educational programs with up-to-date changes	6
		• Adapting educational goals to society's needs and improving their efficiency	3
		• Coordinating technical and vocational education programs with CSA	4
		• Setting the goals of the curriculum in order to solve the future challenges of the Earth	6
		• Fitting educational goals with trainee's needs	4
		• Adopting systemic thinking in education	5
		• Identifying the real needs of society regarding CSA	4

climate change challenges. Obviously, curriculum researchers and experts, as the most important capital of the educational system, play a fundamental role in achieving this mission. Previous studies (Handayani, 2021; Kombat et al., 2021; Ahmed et al., 2022) have reported results similar to our findings.

To respond to climate change effectively, an educational system must consider diverse processes and activities. The question is whether the educational system of agricultural vocational schools can respond to trainees' needs and adapt them to climate change. It is currently difficult to achieve this goal. The trainees' lack of access to proper technologies that are compatible with climate change is the biggest barrier to their ability to provide services efficiently. This problem can be solved by reinforcing the links between research centers and educational centers. The need for conducting research on climate by both research and academic centers is self-evident. Based on our results, educational decentralization is the most appropriate solution from the perspective of causal conditions to develop and implement a CSA-based curriculum. This has been emphasized by other researchers, too (Salter and Maxwell, 2016; Stevenson et al., 2017; Karsantik and Tan Şişman, 2021).

Non-interactive educational content, weakness in skill-oriented educational content, weakness in content updating, traditional teaching, weakness in promoting analytical skills, weakness in trainees' effective learning, and learning inefficiency influence the development and implementation of a CSA-based curriculum as contextual conditions. It can be understood that trainees in agricultural vocational schools are educated with a traditional method, and most of them lack such skills as group making, systemic thinking, knowledge management, networking, conflict settlement, and negotiation. In the meantime, most managerial decisions regarding climate change must be adopted collectively, so agricultural trainers should be capable of forming groups of trainees and triggering group discussions for opinion sharing. Educating the content by explaining it to students can be useful. Learning by education can be effective when students have well understood the educational content. This finding is supported by previous studies (Mahapatra and Satapathy, 2016; Lachner et al., 2022; Mohammed et al., 2023).

Improper teaching, lack of teaching diversity, lack of exploratory teaching, weakness in strengthening problem-solving skills, poor visual content, poor textual content, and poor fitness of evaluation methods with educational goals adversely impact the development and implementation of a CSA-based curriculum in agricultural vocational schools. These factors are especially involved in realizing and forming a CSA-based curriculum. Trainees' lack of knowledge and awareness about climate change in agricultural vocational schools and their unawareness of how to manage climate change risks are challenges of the agricultural education system. Therefore, educational institutions, including agricultural vocational schools, must detect

TABLE 5 The concepts and categories identified about the consequences of CSA-oriented content development for the curriculum of agricultural vocational schools.

Selective code	Axial code	Concepts (initial codes)	Frequency
Consequences	Promoting trainers' professional skills	• Increasing trainers' flexibility regarding new knowledge	2
		• Trainers' efforts in improving trainees' knowledge and skills	5
		• Considering trainers' professional development	1
		• Developing the necessary knowledge and skills regarding curriculum development	3
		• Increasing trainers' willingness to use new technologies	5
		• Developing trainers' expertise in teaching	4
		• Increasing administrators and trainers' participation in implementing the curriculum	2
		• Using experts in the field of curriculum to develop programs	6
	Improving personal abilities	• Selecting creative and research-minded teachers	4
		• Fostering trainers with teamwork thinking	2
		• Using in-service training regarding CSA	3
		• Improving trainers' professional competencies	5
		• Increasing trainers' experience of and commitment to CSA	1
	Using new methods in teaching	• Using the discussion method	2
		• Adopting collaborative learning in education	5
		• Updating educational systems in Iran's agricultural vocational schools	2
		• Increasing topics related to CSA in the curriculum	
	Evaluating trainees' ability to use CSA	• Paying serious attention to evaluating trainees' achievement	6
		• Evaluating trainees' ability and skill learning	4
		• Increasing the efficiency of the final exam in evaluating trainees	2
		• Assessment based on learning, not grades	4
		• The use of diagnostic and continuous self-assessment	4
		• Trainers' adequate command of different assessment methods	2

multiple educational methods and use their capacities and potential to raise awareness of climate change and solutions to mitigate it swiftly and precisely. The institutions in charge should also provide schools, especially agricultural vocational schools, with software (human resources) and hardware facilities (equipment and physical sources). This agrees with previous studies (Salter and Maxwell, 2016; Raghuvanshi and Ansari, 2017; Dhal, 2021; Esringü and Toy, 2022).

Developing and implementing a curriculum needs attention to performance goals, executive (behavioral) goals, and approach goals. By adopting these strategies, one can hope to increase attention to CSA in the curriculum of agricultural vocational schools. The educational system should identify students' knowledge and skill needs by using various techniques, e.g., information gap analysis, and thereby present continuous and directed educational programs. Since fast response to climate change plays an essential role in effective risk management, curricula should introduce technologies that are compatible with local conditions in each region. In this regard, not only should curricula consider the dissemination of new climate change management techniques, but efforts should also be made to transfer simple techniques and technologies that can contribute to reinforcing farmers' resilience against climate change. Our findings corroborate the results of some studies (Neve and Collett, 2018; Esringü and Toy, 2022; Lachner et al., 2022).

Consequences result from strategies and actions taken to cope with and mitigate the challenges of developing and implementing a curriculum. The distinctive roles of agricultural trainers include managerial role (checking the status, needs analysis, organizing, coordinating, executing, monitoring, and evaluating), executive and educational role (training, consultation, researching, and publishing innovations), guiding role (leadership and intervention), social role (making trust and drawing the cooperation of trainees), motivating role, empowering role (knowledge and skill), and technical role (providing technical consultations and training). In general, agricultural trainers need various skills, including knowledge and information, personal-professional, social-psychological, and research skills, to play these roles desirably. Previous researchers (Cleary et al., 2017; Heikkilä et al., 2017; Barnes et al., 2018; Neve and Collett, 2018) have reported similar results.

5 Conclusions and policy implications

Climate change is an unavoidable reality of the current and future centuries. Although efforts to curb greenhouse gas emissions can slow it down, we will inevitably face some of these changes. In this regard, the educational system of agricultural vocational schools should

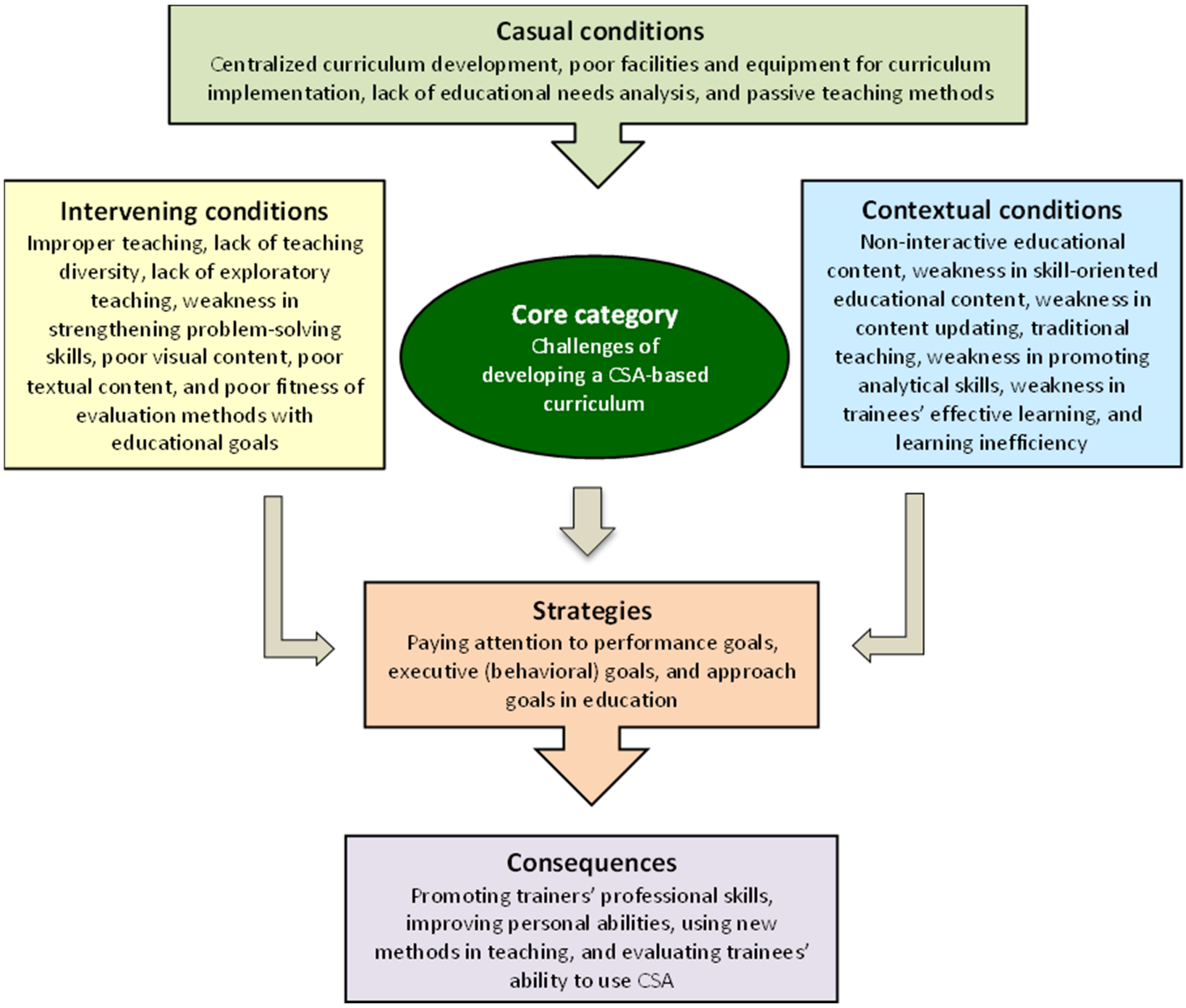

FIGURE 1
The conceptual model of the research.

consider suitable mechanisms to increase adaptation to climate change, which requires developing and implementing a CSA-based curriculum. Given the current challenges in the curriculum of agricultural vocational school, the educational system should change its orientation to select the best curriculum for coping with climate change and variability. Trainers play an undeniable role in increasing the response of educational systems to climate change challenges. Therefore, the educational system of agricultural vocational schools should not only recruit efficient trainers who are specialized in CSA but also make appropriate investments in improving a curriculum based on modern technologies. In addition, they must consider improving the organization of trainers and human resources development and pay special attention to empowering trainees in agricultural vocational schools, so managers and trainers can work with more authority and be more effective in implementing the CSA-based curriculum.

As with other studies, this research has some limitations whose removal can pave the way for further quantitative and qualitative studies. First, the statistical population was composed of the researchers, authors, managers, and experts of the Office of Textbook Compilation of the Organization for Educational Research and Planning and the Research Center of Educational Studies. Although they provided invaluable insight into curriculum implementation in agricultural vocational schools, the results may be different for other statistical populations. It is therefore recommended to conduct the research at other educational levels and make a comparison between the results. The second limitation is that only agricultural vocational schools in Iran were studied. So, there is a chance to conduct a similar study on other countries' agricultural, technical, and vocational schools and compare the results. The third limitation is related to the novelty of the topic, which reduced the literature available for developing a theoretical framework. Thus, researchers are recommended to use the proposed conceptual paradigm as a basis to solve the challenges of implementing a CSA-based curriculum in agricultural vocational schools.

Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: the original contributions presented in the study are included in the article/supplementary material; further inquiries can be directed to the corresponding author. Requests to access these datasets should be directed to mehrdad.niknami@iau.ac.ir.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the patients/participants or patients/participants legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

MJ: Conceptualization, Formal analysis, Investigation, Resources, Data curation, Software, Writing – original draft. MN: Formal analysis, Investigation, Conceptualization, Methodology, Resources, Supervision, Validation, Writing – review & editing. MS: Methodology, Validation, Writing – review & editing. MB: Conceptualization, Investigation, Methodology, Resources, Validation, Visualization, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Acknowledgments

The authors feel it necessary to express their gratitude to all those who helped in different stages of this research.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

Agus, E., and Ali, K. (2022). Environmental Education for High School and Vocational School of Muhammadiyah City of Medan Based on Islam. *Budapest Int. Res. Critics Inst. J.* 5, 930–937. doi: 10.33258/birci.v5i1.3690

Ahmed, A., Ibrahim, O., and Agunbiade, M. (2022). Integrating climate change and smart agriculture contents into Nigerian school curriculum. *Indonesian J. Curricu. Educ. Technol. Stud.* 10:1. doi: 10.15294/ijcets.v10i1.50938

Alliagbor, R., Awolala, D. O., and Ajibefun, I. A. (2021). Smallholders Use of Weather Information as Smart Adaptation Strategy in the Savannah Area of Ondo State, Nigeria. In N. Oguge, D. Ayal, L. Adeleke and SilvaI. da (Eds.), *African Handbook of Climate Change Adaptation*. Springer, Cham.

Barnes, A. E., Zuilkowski, S. S., Mekonnen, D., and Ramos-Mattoussi, F. (2018). Improving teacher training in Ethiopia: shifting the content and approach of pre-service teacher education. *Teach. Teach. Educ.* 70, 1–11. doi: 10.1016/j.tate.2017.11.004

Belay, B., Ambaw, G., Amha, Y., Makonnen, B., and Solomon, D. (2022). Streamlining Climate Change, Climate Risk Management in Agriculture, Climate Information Services, and Climate-Smart Agriculture Innovations Into Undergraduate University Curriculum Modules in Ethiopia. Available at: https://hdl.handle.net/10568/125088

Berhanu, A. A., Ayele, Z. B., and Dagnew, D. C. (2024). Impact of climate-smart agricultural practices on smallholder farmers' resilience in Ethiopia. *J. Agric. Food Res.* 16:101147. doi: 10.1016/j.jafr.2024.101147

Campbell-Phillips, S. (2020). Education and curriculum reform: the impact they have on learning. *Budapest Int. Res. Critics. Linguist. Educ. J.* 3, 1074–1082. doi: 10.33258/birle.v3i2.1036

Chauhan, A., Rani, A., Kumari, A., and Singh, R. N. (2022). "Chapter 5: Climate-smart agriculture: an integrated approach for attaining agricultural sustainability" in *Climate Change and Resilient Food Systems*, vol. *5* (Singapore: Springer), 141–189.

Chetti, M. B., Ashalatha, K. V., and Dolli, S. S. (2022). Needs and Challenges of Smart Agriculture and Entrepreneurship Education – A Case Study by the University of Agricultural Sciences, Dharwad, Karnataka, India. Conference on Computers in Education, Digital Transformation of Education and Learning - Past, Present and Future, 192–201.

Cleary, T. J., Velardi, B., and Schnaidman, B. (2017). Effects of the self-regulation empowerment program (SREP) on middle school students' strategic skills, self-efficacy, and mathematics achievement. *J. Sch. Psychol.* 64, 28–42. doi: 10.1016/j.jsp.2017.04.004

Corbin, J., and Strauss, A. (2012). *Basics of Qualitative Research, Techniques and Procedures for Developing Grounded Theory*. Thousand Oaks, USA: San Jose State University.

Coulibaly, T. P., Du, J., and Diakité, D. (2021). Sustainable agricultural practices adoption. *Agriculture (Pol'nohospodárstvo)* 67, 166–176. doi: 10.2478/agri-2021-0015

Danai Fard, H., and Eslami, A. (2021). *Applying Foundational Data Theory in Practice: Building a Theory of Organizational Indifference. 2nd* Edn. Tehran: Imam Sadegh University Press.

Derbile, E. K., Chirawurah, D., and Naab, F. X. (2022). Vulnerability of smallholder agriculture to environmental change in North-Western Ghana and implications for development planning. *Clim. Dev.* 14, 39–51. doi: 10.1080/17565529.2021.1881423

Dhal, P. K. (2021). Education for climate change, environmental sustainability and world peace. *SSRN Electron. J.* doi: 10.2139/ssrn.3981679

Esringü, A., and Toy, S. (2022). The Effect of Climate Change Education on the Knowledge and Awareness Levels of Atatürk University Students TT - Atatürk Üniversitesi Örneklemi'nde İklim Değişikliği Eğitiminin Üniversite Öğrencilerinin Bilgi ve Farkındalık Düzeylerine Etkisi. *Kent Akademisi* 15, 595–610. doi: 10.35674/kent.1041157

Fentie, A., and Beyene, A. D. (2019). Climate-smart agricultural practices and welfare of rural smallholders in Ethiopia: does planting method matter? *Land Use Policy* 85, 387–396. doi: 10.1016/j.landusepol.2019.04.020

Gebru, G. W., Ichoku, H. E., and Phil-Eze, P. O. (2020). Determinants of smallholder farmers' adoption of adaptation strategies to climate change in eastern Tigray National Regional State of Ethiopia. *Heliyon* 6:e04356. doi: 10.1016/j.heliyon.2020.e04356

Gokmenoglu, T., Yavuz, İ., and Sensin, C. (2023). Exploring the interplay between curriculum and textbooks in disaster risk reduction education: insights and implications. *Int. J. Disaster Risk Reduct.* 96:103949. doi: 10.1016/j.ijdrr.2023.103949

Handayani, I. (2021). Science of climate change in agricultural courses, Sriwijaya. *Int. Conf. Earth Sci. Environ. Issue* 810:012029. doi: 10.1088/1755-1315/810/1/012029

Heikkilä, A.-S., Vuopala, E., and Leinonen, T. (2017). Design-driven education in primary and secondary school contexts. A qualitative study on teachers' conceptions on designing. *Technol. Pedagog. Educ.* 26, 471–483. doi: 10.1080/1475939X.2017.1322529

Jomegi, M., and Lashgarara, F. (2013). Challenges of applying information and communication technology from the perspective of students of agricultural colleges in Tehran province *J. Agric. Ext. Educ. Res.* 5, 19–30.

Jomegi, M., Niknami, M., Saboori, M. S., and Bijani, M. (2023). Smart climate agriculture and its place in Iran's secondary technical knowledge textbooks: the application of content analysis. *J. Educ. Innov.* 2, 67–87. doi: 10.22034/JEI.2024.401219.2662

Karmi, S., Fathi Vajargah, K., Khosravi Babaei, A., and Faraj-zadeh Asl, M. (2019). Green curriculum in Iran's higher education system: water crisis, climate change, sources of knowledge. *Environ. Educ. Q. Sustain. Dev.* 9, 81–94,

Karsantik, Y., and Tan Şişman, G. (2021). Curriculum development in Singapore and Turkey: reflections of administrative structure and educational reforms TT - Singapur ve Türkiye'de Yönetsel Yapı ve Eğitim Reformları Bağlamında program Geliştirme Süreçleri. *Bartın Univ. J. Fac. Educ.* 2021, 109–131. doi: 10.14686/buefad.704869

Khatri-Chhetri, A., Regmi, P. P., Chanana, N., and Aggarwal, P. K. (2020). Potential of climate-smart agriculture in reducing women farmers' drudgery in high climatic risk areas. *Clim. Chang.* 158, 29–42. doi: 10.1007/s10584-018-2350-8

Koirala, A., and Bhandari, P. (2020). Impact of climate change on livestock production. *Nepalese* 1, 178–183,

Kombat, R., Sarfatti, P., and Fatunbi, O. A. (2021). A review of climate-smart agriculture technology adoption by farming households in sub-Saharan Africa. *Sustain. For.* 13:12130. doi: 10.3390/su132112130

Kumar, P., Sahani, J., Rawat, N., Debele, S., Tiwari, A., Mendes Emygdio, A. P., et al. (2023). Using empirical science education in schools to improve climate change literacy. *Renew. Sust. Energ. Rev.* 178:113232. doi: 10.1016/j.rser.2023.113232

Lachner, A., Hoogerheide, V., van Gog, T., and Renkl, A. (2022). Learning-by-teaching without audience presence or interaction: when and why does it work? *Educ. Psychol. Rev.* 34, 575–607. doi: 10.1007/s10648-021-09643-4

Mahapatra, P., and Satapathy, S. (2016). Skills, schools and employability: developing skill based education in schools of India. *J. Soc. Sci.* 12, 99–104. doi: 10.3844/jssp.2016.99.104

Mohammed, Z. J., Alsadaji, A. J., Al-Saadi, S. F., and Al-Fayyadh, S. (2023). Components of soft skills for university students in the 21st century: an overview of literature review. *Med. Educ. Bull.* 4, 601–611. doi: 10.22034/MEB.2023.389121.1076

Moradi, E., and Didehban, H. (2017). Faculty members development in medical education: programs, interventions and outcomes. *Nurs. Midwifery J.* 15, 10–18,

Morote, R., Anyan, F., Las Hayas, C., Gabrielli, S., Zwiefka, A., Gudmundsdottir, D. G., et al. (2020). Development and validation of the theory-driven school resilience scale for adults: preliminary results. *Child Youth Serv. Rev.* 119:105589. doi: 10.1016/j.childyouth.2020.105589

Neve, H., and Collett, T. (2018). Empowering students with the hidden curriculum. *Clin. Teach.* 15, 494–499. doi: 10.1111/tct.12736

Pacillo, G., Kangogo, D., Madurga-Lopez, I., Villa, V., Belli, A., and Läderach, P. (2022). Is climate exacerbating the root causes of conflict in Mali? A climate security analysis through a structural equation modeling approach. *Front. Climate* 4:849757. doi: 10.3389/fclim.2022.849757

Partey, S. T., Zougmoré, R. B., Ouédraogo, M., and Campbell, B. M. (2018). Developing climate-smart agriculture to face climate variability in West Africa: challenges and lessons learnt. *J. Clean. Prod.* 187, 285–295. doi: 10.1016/j.jclepro.2018.03.199

Pormoid, S., and Yazdakhasi, A. (2021). The Challenges of Developing Content with a Community Approach in the Curriculum of Higher Education. The 7th International Conference on Humanities, Social and Lifestyle Sciences.

Raghuvanshi, R., and Ansari, M. A. (2017). A study of farmers' awareness about climate change and adaptation practices in India. *Young Less Than* 3, 154–190. doi: 10.11648/j.ijaas.20170306.13

Romanello, M., Di Napoli, C., Drummond, P., Green, C., Kennard, H., Lampard, P., et al. (2022). The 2022 report of the lancet countdown on health and climate change: health at the mercy of fossil fuels. *Lancet* 400, 1619–1654. doi: 10.1016/S0140-6736(22)01540-9

Salter, P., and Maxwell, J. (2016). The inherent vulnerability of the Australian curriculum's cross-curriculum priorities. *Crit. Stud. Educ.* 57, 296–312. doi: 10.1080/17508487.2015.1070363

Simanjuntak, M. B., Suseno, M., Setiadi, S., Lustyantie, N., and Barus, I. R. G. R. G. (2022). Integration of curricula (curriculum 2013 and Cambridge curriculum for junior high school level in three subjects) in pandemic situation. *Ideas. Jurnal Pendidikan, Sosial, Dan Budaya* 8, 77–86. doi: 10.32884/ideas.v8i1.615

Stevenson, R., Nicholls, J., and Louise Whitehouse, H. (2017). What is climate change education? *Curric. Perspect.* 37, 67–71. doi: 10.1007/s41297-017-0015-9

Tadesse, B., and Ahmed, M. (2023). Impact of adoption of climate-smart agricultural practices to minimize production risk in Ethiopia: a systematic review. *J. Agric. Food Res.* 13:100655. doi: 10.1016/j.jafr.2023.100655

Taghibaygi, M., and Khosravipour, B. (2020). Pathology of vocational agricultural training centers from the perspective of students, administrators, and trainers. *Technol. Educ. J.* 14, 629–642,

Tavassoti, A., Niknami, M., Hosseini, F., Sayed, J., and Omidi Najafabadi, M. (2021). Modeling farmers' behavior in optimal Management of Agricultural Water Consumption Based on smart climate agriculture in Pakdasht County: application of planned behavior theory. *Agric. Ext. Educ. Res.* 14, 84–102,

Waaswa, A., Nkurumwa, A. O., and Kibe, A. M. (2021). Communicating climate change adaptation strategies: climate-smart agriculture information dissemination pathways among smallholder potato farmers in Gilgil Sub-County, Kenya. *Heliyon* 7:e07873. doi: 10.1016/j.heliyon.2021.e07873

Wahyudi, I., Fuadi, I., and Naim, N. (2020). Implementation of the curriculum in enhancing the quality of education at Sman 1 Blitar and man 2 Kediri. *Int. J. Arts Commerce* 9, 13–20,