









# Upper Secondary Students' Perceptions of Underutilized Food Resources in Rwanda: Awareness, Attitudes, and Barriers to Utilization

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**Abstract.** *Underutilized food resources comprising neglected indigenous plants, animals, and fungi; hold substantial potential for improving food security, dietary diversity, and nutritional outcomes. Yet, they remain poorly integrated into mainstream diets, particularly among youth. This study investigated upper secondary students' perceptions of, and engagement with, underutilized food resources in Rwanda, with a focus on awareness levels, attitudes, and barriers to practical utilization. A mixed-methods design was employed, combining structured questionnaires administered to a stratified random sample of 52 students (drawn from a target population of 107 students) and 6 staff at Ecole Secondaire Saint Joseph le Travailleur, focus group discussions (n = 4 groups), and semi-structured interviews with teachers and school leaders. Data were analyzed using descriptive statistics in Microsoft Excel. Fourteen categories of underutilized food resources were identified across the Animalia, Plantae, and Fungi kingdoms. Regarding awareness, only 17% of students demonstrated comprehensive knowledge, 29% reported partial knowledge, and 54% had minimal knowledge. A comparable pattern emerged for actual consumption: 17% used these resources regularly, 29% occasionally, and 54% rarely. Barriers included limited availability in local markets, unfamiliarity with preparation methods, cultural taboos, and insufficient integration into school meal programs. A significant awareness-utilization gap exists among Rwandan secondary school students regarding underutilized food resources. Targeted educational interventions, curriculum integration, and school feeding program reforms are recommended to bridge this gap and improve dietary diversity and food security outcomes.*

**Keywords:** *underutilized food resources, student perceptions, food security, Rwanda, indigenous vegetables, dietary diversity & neglected crops*

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## 1. Introduction

Global food systems face mounting pressures from population growth, climate change, and the narrowing of dietary diversity. The world population is projected to reach approximately 10 billion by 2050, yet food production growth has not kept pace, and approximately 820 million people remain chronically undernourished (Adewoyin et al., 2017; Awoyinka et al., 1995). One underexplored strategy to address these twin challenges of food insecurity and nutritional deficiency is the promotion of underutilized food resources as edible species that are locally available but insufficiently exploited due to knowledge gaps, cultural barriers, or limited market integration (Bain et al., 2013; Brown et al., 2018).

Underutilized food resources are broadly defined as consumable organisms including plants, animals, and fungi that are available in a given ecosystem but not fully exploited, despite possessing nutritional, economic, and ecological value (Campbell & Reece, 2008). They differ from so-called 'alternative' foods in that they are not exotic imports but rather indigenous species embedded in local environments and cultural histories. Their potential to contribute to food security, malnutrition reduction, biodiversity conservation, and climate resilience has been increasingly recognized in scientific literature (Cardozo & Morales, 2019; Chauhan et al., 2023).

Globally, the distribution of underutilized food resources is broad but context-specific. In South and Southeast Asia, millets, buckwheat, and wild vegetables provide essential nutrients and enhance dietary diversity (Cullen et al., 2015). Across the Americas, quinoa, amaranth, and chayote are rich in protein, essential amino acids, and vitamins (Chauhan et al., 2023). In Africa, species such as Fonio, Teff, Baobab, Moringa, Bambara groundnut, and African yam bean remain chronically underexploited despite high nutritional profiles and resilience to local agro-ecological conditions (FAO, 2023; Galluzzi & López Noriega, 2014).

In Rwanda specifically, the agricultural sector supports over 70% of the population, yet national nutrition surveys consistently report high rates of micronutrient deficiencies, particularly among children and women of reproductive age (Giraldi & Hanazaki, 2014; Hoeschle-Zeledon et al., 2009). Rwanda harbors diverse indigenous food species including spider plant (isogi), amaranth (dodo), pumpkin leaves, cassava leaves, bean leaves, taro, and edible mushrooms that could meaningfully contribute to dietary diversity and food security if better integrated into local diets. Yet their utilization remains limited, and their nutritional potential largely unrealized.

Youth, and secondary school students in particular, represent a critical demographic for food systems transformation. Their dietary habits are still being formed, they are potential future agricultural actors, and schools provide structured platforms for nutrition education. Understanding how adolescent students perceive underutilized food resources; what they know, how they feel about consuming these foods, and what prevents them from doing so, is therefore a necessary precondition for designing effective interventions (Landim et al., 2024; MINAGRI, 2018).

Despite growing research on underutilized food resources globally, studies focusing specifically on youth perceptions within a Rwandan secondary school context are scarce. This study seeks to fill that gap by investigating upper secondary students' awareness, attitudes, and actual utilization of underutilized food resources at Ecole Secondaire Saint Joseph le Travailleur (ESSJT), a vocational school with a Food and Beverage Operations track. The study pursued three specific objectives: (1) to identify and classify underutilized food resources present in Rwanda; (2) to analyze students' perceptions of these resources; and (3) to assess the extent and barriers of their actual utilization among students.

## 2. Materials and Methods

### 2.1 Study Design and Setting

This study adopted a descriptive, mixed-methods research design, integrating both quantitative survey data and qualitative insights from focus group discussions (FGDs) and semi-structured interviews. The research was conducted at Ecole Secondaire Saint Joseph le Travailleur (ESSJT), a secondary school in Rwanda offering a Food and Beverage Operations (FBO) specialization at upper secondary level (Levels 3 and 4). The school was purposively selected as a relevant study site given its food-related curriculum, which positions students to have potentially greater exposure to food diversity and nutrition concepts than the general secondary school population.

### 2.2 Target Population and Sampling

The target population comprised all students enrolled in the Food and Beverage Operations track at ESSJT, as well as teachers and school leaders with relevant subject matter knowledge, totaling 113 individuals. The population distribution is presented in Table 1.

**Table 1**

Research population distribution, Ecole Secondaire Saint Joseph le Travailleur

Category	Level 3 (2 classes)	Level 4	Teachers & Leaders	Total
Male students	12	11	—	23
Female students	49	35	—	84
Teachers	—	—	4	4
School leaders	—	—	2	2
<b>Total</b>	<b>61</b>	<b>46</b>	<b>6</b>	<b>113</b>

Source: Primary data, 2025

The sample size for the student stratum was calculated using Yamane's (1967) formula for finite populations:

$$n = N / (1 + N \cdot e^2)$$

Where N = 107 (total student population) and e = 0.1 (margin of error). This yielded a student sample of n = 52. All four teachers and both school leaders were included as census respondents, yielding a total sample of 58 participants. Stratified random sampling was applied across the three class levels to ensure proportional representation by gender and class.

### 2.3 Data Collection Instruments

Three complementary instruments were used. First, a structured questionnaire with both closed (Likert-scale and checklist) and open-ended items was administered to 52 student respondents. The questionnaire covered: (a) respondent sociodemographic characteristics; (b) identification of known underutilized food resources; (c) perceptions and attitudes toward these resources; and (d) frequency of consumption and barriers to utilization. Second, focus group discussions (FGDs) were conducted with four groups of 13 students each, guided by a semi-structured protocol exploring knowledge depth, cultural influences, and suggested interventions. Third, semi-structured individual interviews were conducted with four teachers and two school leaders to obtain expert and institutional perspectives on underutilized food resource education and integration. Secondary data, including scientific literature and internet-sourced documentation, were additionally used to compile a

comprehensive catalogue of underutilized food resources relevant to Rwanda's agro-ecological context.

### 2.4 Data Analysis

Quantitative data from student questionnaires were entered and analyzed in Microsoft Excel, generating descriptive statistics including frequencies and percentages. Qualitative data from FGDs and interviews were analyzed thematically, with emerging codes organized into overarching themes aligned with the study objectives. Convergence and divergence between quantitative and qualitative findings were examined to enhance the validity of interpretations.

### 2.5 Ethical Considerations

Participation was voluntary, and informed consent was obtained from all respondents. For minor participants, assent was obtained alongside parental/guardian consent through the school administration. Confidentiality and anonymity were maintained throughout data collection, analysis, and reporting. No personal identifiers were retained in the dataset.

## 3. Results

### 3.1 Identification and Classification of Underutilized Food Resources in Rwanda

The first objective of the study was to identify and classify underutilized food resources available in Rwanda. Drawing on documentary review and student self-reports, the research identified 14 categories of underutilized food resources, organized according to their biological kingdom: Animalia, Plantae, and Fungi (Table 2).

**Table 2**

Classification of identified underutilized food resources in Rwanda

Kingdom	Category	Common Name(s)	Scientific Name / Local Name	Nutritional Highlights
Animalia	Insects	Flying termites	<i>Macrotermes spp.</i>	High protein, fat, micronutrients
Animalia	Birds	Dove and pigeon	<i>Edible spp.</i>	Lean protein, calcium
Animalia	Rodents	Mole rat	<i>Tachyoryctes splendens (ifuku)</i>	Protein, iron
Animalia	Small mammals	Guinea pig	<i>Cavia porcellus (sumbirigi)</i>	High-quality protein, B-vitamins
Animalia	Fish	Walking catfish	<i>Clarias gariepinus</i>	Protein, omega fatty acids
Plantae	Leafy vegetables	Spider plant	<i>Cleome gynandra (isogi)</i>	Iron, beta-carotene, folate
Plantae	Leafy vegetables	Amaranth leaves	<i>Amaranthus spp. (dodo)</i>	Protein, iron, vitamins A & C
Plantae	Leafy vegetables	Pumpkin leaves	<i>Cucurbita pepo</i>	Vitamins A, C, calcium
Plantae	Leafy vegetables	Cassava leaves	<i>Manihot esculenta</i>	Protein, minerals (requires detox)

Kingdom	Category	Common Name(s)	Scientific Name / Local Name	Nutritional Highlights
Plantae	Leafy vegetables	Bean leaves	<i>Phaseolus vulgaris</i> (ibijumba)	Vitamin A, iron, zinc
Plantae	Corms/tubers	Taro	<i>Colocasia esculenta</i>	Carbohydrates, vitamins, minerals
Plantae	Wild fruits	African nightshade	<i>Solanum nigrum</i>	Vitamins, antioxidants
Plantae	Cereals	Finger millet	<i>Eleusine coracana</i>	Calcium, iron, dietary fiber
Fungi	Mushrooms	Wild edible mushrooms	<i>Various spp.</i>	Protein, B-vitamins, trace minerals

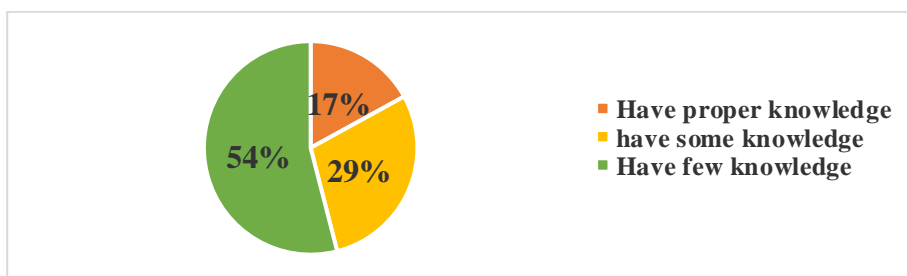
Source: Field data and documentary review, 2025

Many of these species are well-documented in the scientific literature for their nutritional density, climate resilience, and suitability for local growing conditions. For instance, amaranth (*Amaranthus* spp.) is widely recognized as a high-protein, iron- and vitamin-rich crop well-adapted to semi-arid conditions (Tyagi et al., 2017). Cassava leaves (*Manihot esculenta*) have been documented as a significant source of protein in sub-Saharan Africa (Awoyinka et al., 1995). Bean leaves represent an inexpensive but nutritionally valuable source of vitamin A, iron, and zinc (Wangila, 2014), while taro leaves provide a range of essential vitamins and minerals (Chauhan et al., 2023). Flying termites and guinea pigs, among the animal resources, are associated with high protein and nutritional quality (Cardozo & Morales, 2019; Wallenbeck & Jönsson, 2016).

### 3.2 Students' Perceptions and Awareness of Underutilized Food Resources

The second objective examined students' perceptions and level of knowledge about underutilized food resources. Focus group discussions and individual questionnaire responses produced a consistent pattern in which students hold broadly positive attitudes toward underutilized foods but possess varying and often superficial levels of knowledge.

As illustrated in Figure 1, of the 52 students surveyed, 9 (17%) demonstrated comprehensive knowledge. They could identify multiple species, describe their nutritional benefits, and articulate preparation methods. Fifteen students (29%) had partial knowledge because they recognized some species but lacked depth on nutritional or culinary dimensions. The majority, 28 students (54%), had minimal knowledge, unable to name or describe most underutilized food resources or articulate their benefits.



**Figure 1**

Students' self-reported knowledge levels of underutilized food resources (n = 52).

Source: Field data, 2025

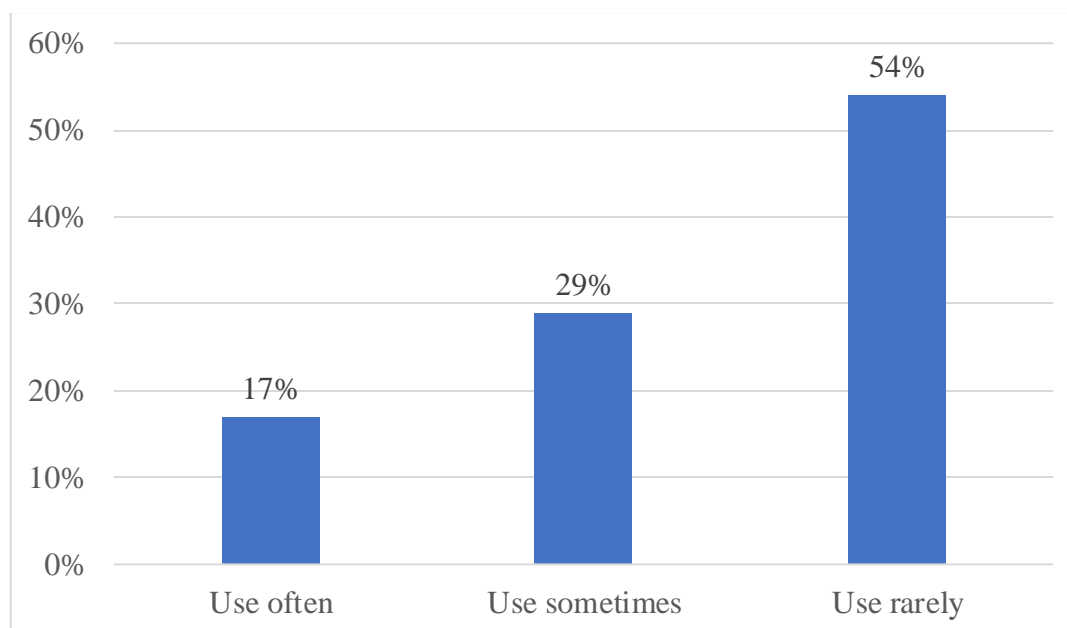
[Figure 1 — Pie chart: Distribution of students' knowledge levels on underutilized food resources (n = 52). Categories: Comprehensive 17%, Partial 29%, Minimal 54%. Insert actual figure file here.]

Qualitatively, FGD participants consistently expressed positive attitudes toward underutilized foods when presented with information about them. Students acknowledged their nutritional value and cultural significance, often referencing grandparents or rural relatives who consumed them regularly. However, they simultaneously described social norms particularly peer influence and the perceived 'modernity' of processed and imported foods as discouraging factors. This finding aligns with Brown et al. (2018), who found that positive perceptions alone are insufficient to drive dietary behavior change without supportive structural and social interventions.

Teachers interviewed noted that the Food and Beverage Operations curriculum contains limited content on indigenous and underutilized species, and that students' awareness was largely driven by family background rather than formal education. School leaders acknowledged interest in expanding the curriculum but cited resource constraints.

### 3.3 Exploitation and Consumption of Underutilized Food Resources

The third objective assessed the degree to which students actually consume underutilized food resources in their daily lives. Findings revealed a pronounced gap between awareness and practice. As shown in Figure 2, only 9 students (17%) reported regularly incorporating underutilized food resources into their diet, while 15 (29%) consumed them occasionally, and 28 students (54%) rarely or never consumed them.



**Figure 2**

Frequency of consumption of underutilized food resources among students (n = 52).

Source: Field data, 2025

[Figure 2 — Bar chart: Frequency of consumption of underutilized food resources among students (n = 52). Categories: Regular 17%, Occasional 29%, Rare/Never 54%. Insert actual figure file here.]

Multiple barriers to utilization were identified through both the questionnaire and FGD responses. Students cited the following as the most significant obstacles. The limited availability Explained with many species that are not readily found in local markets or near students' homes, particularly for students from urban areas. Unfamiliarity with preparation methods as another barrier where students reported not knowing how to safely and palatably prepare many species, particularly leafy vegetables (e.g., cassava and taro leaves require specific detoxification techniques) and animal products (e.g., walking catfish, flying termites). In terms of cultural and social taboos, several students described family or community restrictions on consuming certain animals (e.g., mole rat, guinea pig) or plant species, particularly among youth. An absence from school meals, the statement said none of the

identified underutilized species were part of the school's regular meal program, removing an important institutional pathway for exposure. Lastly, aesthetic and social preferences or peer influence and aspirational preferences for 'modern' processed foods reduced motivation to consume indigenous species.

Students who did consume these resources regularly were significantly more likely to come from rural backgrounds, report family members who also consumed them, or have received prior instruction on preparation methods, highlighting the role of social learning and early exposure in shaping utilization behavior (Hoeschle-Zeledon et al., 2009; Nguyen & Lee, 2019).

#### 4. Discussion

This study provides empirical evidence of a well-documented but understudied phenomenon in the Rwandan context: the gap between positive perceptions of underutilized food resources and their limited practical adoption among secondary school youth. The finding that 54% of students have minimal knowledge and rarely consume these foods, despite attending a vocational school with a food specialization, is particularly striking and underscores the depth of the challenge.

A particularly noteworthy finding of this study is the striking congruence between the results of students' perceptions and awareness (Section 3.2) and their actual exploitation and consumption behavior (Section 3.3). In both dimensions, respondents distributed themselves in virtually identical proportions: 17% demonstrated comprehensive knowledge and regular consumption, 29% exhibited partial knowledge and occasional consumption, and 54% fell into the minimal knowledge and rare/never consumption categories. This parallel agreement pattern strongly suggests that awareness and behavior are deeply interlinked. Students who know more about underutilized food resources are also those who consume them most frequently, and conversely, those with limited awareness are consistently those who rarely or never incorporate these foods into their diets. This alignment is consistent with the knowledge-attitude-practice (KAP) framework, which posits that knowledge acquisition is a foundational precursor to behavioral adoption in nutritional contexts (Landim et al., 2024).

Similar congruence between knowledge levels and consumption frequency has been documented in studies of indigenous food utilization among youth in sub-Saharan Africa. Adewoyin et al. (2017) reported that rural Nigerian youth who demonstrated greater familiarity with underutilized indigenous vegetables were significantly more likely to consume them, reinforcing the notion that awareness, while insufficient on its own, tracks closely with dietary behavior. Likewise, Giraldi and Hanazaki (2014) observed that communities with richer ethnobotanical knowledge maintained stronger connections to traditional food consumption practices. In the present study, the identical percentage distributions across knowledge and consumption categories as a phenomenon not commonly reported with such precision in the literature may reflect the role of experiential learning confirming that students likely come to know underutilized foods primarily through the experience of consuming them in family or community settings, rather than through formal education (Hoeschle-Zeledon et al., 2009; Nguyen & Lee, 2019). This interpretation is further supported by the qualitative findings, wherein FGD participants attributed their awareness of underutilized resources primarily to grandparents and rural relatives rather than school curricula. The convergence of awareness and practice data thus has direct implications for intervention design: increasing knowledge alone, without simultaneously creating opportunities for exposure and consumption, is unlikely to shift behavioral patterns. Integrated approaches that combine nutrition education with practical cooking experiences and school meal diversification are therefore essential (Padulosi et al., 2013; Smith & Jones, 2020).

The pattern mirrors findings from analogous studies in West Africa, where Adewoyin et al. (2017) found that rural youth in Osun State, Nigeria demonstrated similarly low consumption of

underutilized indigenous vegetables despite expressed familiarity with some species. It also aligns with Giraldi and Hanazaki (2014), who documented a consistent disconnect between ethnobotanical knowledge and dietary behavior in traditional communities. Collectively, these findings suggest that knowledge and positive attitudes are necessary but not sufficient conditions for behavioral change in food consumption to prove a conclusion consistent with sociological models of food behavior (Landim et al., 2024).

The barriers identified in this study such as limited market access, unfamiliarity with preparation, cultural constraints, and absence from school meal programs are well documented in the literature on underutilized food resources globally (Galluzzi & López Noriega, 2014; Nguyen & Lee, 2019; Hoeschle-Zeledon et al., 2009). However, their presence in a school with a dedicated food and beverage curriculum is particularly notable, suggesting that formal vocational education in Rwanda does not yet provide adequate coverage of indigenous food resources, a gap that represents both a challenge and an opportunity.

The cultural dimensions of underutilization deserve particular attention. Several students referenced taboos or family restrictions around specific animal-based underutilized resources, including the mole rat (ifuku) and guinea pig (sumbirigi). These dynamics reflect broader cultural food systems in which identity, religion, and social norms shape individual dietary choices in ways that transcend purely nutritional or economic reasoning (Landim et al., 2024). Educational interventions targeting underutilized food promotion must therefore be culturally sensitive and community-informed rather than purely information-based.

Importantly, this study also reveals significant potential for change. The 17% of students with comprehensive knowledge and regular consumption habits demonstrate that these resources are not inherently unacceptable to youth but rather that adoption is strongly associated with early exposure, family practice, and cooking confidence. These findings point toward actionable entry points for intervention such as curricula reform, practical cooking workshops, school feeding program diversification, and community engagement can together address the interrelated knowledge, skills, and social dimensions of underutilization.

From a policy perspective, Rwanda's national nutrition and food security programs including those coordinated through MINAGRI and the Rwanda Agriculture and Animal Resources Development Board (RAB) are well-positioned to support underutilized food resource promotion. Ongoing initiatives such as the promotion of rabbit and guinea pig farming indicate growing institutional awareness of the issue, but these efforts require reinforcement through the education sector to reach youth systematically.

A limitation of this study is its single-school, single-region scope, which may constrain the generalizability of findings to the broader Rwandan adolescent population. Additionally, the reliance on self-reported consumption data introduces potential social desirability bias. Future studies should employ multi-site, regionally stratified designs and, where feasible, dietary recall or food frequency questionnaires to provide more objective consumption estimates.

## 5. Conclusion

This study investigated upper secondary students' perceptions of underutilized food resources at Ecole Secondaire Saint Joseph le Travailleur, Rwanda. Fourteen categories of underutilized resources were identified across the Animalia, Plantae, and Fungi kingdoms, many of which are nutritionally dense and well-suited to Rwanda's agro-ecological conditions. The findings reveal that the majority of students (54%) have minimal knowledge of these resources and rarely consume them, despite generally positive attitudes constituting a significant awareness-utilization gap. The barriers to

utilization are multifaceted, encompassing knowledge deficits, practical skills gaps, cultural constraints, limited market access, and absence from school meal programs. Addressing these barriers requires coordinated action across the education, agriculture, and health sectors, underpinned by culturally sensitive, evidence-based approaches. Schools particularly those with vocational food and nutrition tracks represent high-leverage sites for intervention.

Based on these findings, the following recommendations are directed toward relevant stakeholders:

1. Ministry of Education and Rwanda TVET Board (RTB): Integrate underutilized indigenous food resource content into the Food and Beverage Operations curriculum, including identification, nutritional value, safe preparation, and cultural context; mandate practical cooking workshops as part of vocational competency training.
2. Ministry of Agriculture (MINAGRI) and Rwanda Agriculture Board (RAB): Scale up promotion and production support for priority underutilized species through extension services and school outreach; develop and disseminate accessible knowledge materials on underutilized food resources for schools and communities.
3. Ministry of Health and Rwanda Biomedical Centre (RBC): Incorporate promotion of underutilized food resources into national nutrition campaigns; conduct targeted nutrition education in schools in partnership with school health programs.
4. School Administrations: Diversify school meal programs to include underutilized indigenous foods; establish school demonstration gardens featuring underutilized species as educational and food production resources.

### **Directions for Future Research**

Future studies should: (1) assess the nutritional impact of increased consumption of specific underutilized resources on student health outcomes; (2) evaluate the effectiveness of curriculum-based interventions in changing student knowledge and consumption behavior; (3) explore the economic value of underutilized food resources for smallholder farmers in Rwanda; and (4) investigate the role of underutilized food resources in climate adaptation and sustainable agriculture at national scale.

### **Declarations**

**Ethics approval and consent to participate:** Participation was voluntary. Informed consent was obtained from all respondents. For minor participants, assent was obtained alongside parental/guardian consent through the school administration. No personal identifiers were retained.

**Consent for publication:** Not applicable.

**Availability of data and materials:** The datasets supporting the conclusions of this article are available from the corresponding author upon reasonable request.

**Competing interests:** The authors declare no competing interests.

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**Authors' contributions:** EN, BN, JK and CN conceptualized the study and led data collection. SH, EH, LI, and AU contributed to data collection, analysis, and manuscript preparation. All authors reviewed and approved the final manuscript.

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