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ABSTRACT: Rice production in Southeast Vietnam generates a large amount of straw, which is often burnt directly in fields, causing air pollution and affecting community health. This study aims to assess the awareness of the environmental and health impacts of straw burning among farmers, students, and managers in the provinces of Tay Ninh, Binh Phuoc, and Dong Nai, Vietnam. We conducted a survey of 686 individuals, divided into 3 main groups: 349 farmers, 250 students, and 87 local government officials. The survey results, analyzed using exploratory factor analysis (EFA), indicate that 55.2% of farmers never engage in straw burning, while 24.4% report infrequent burning. Awareness of the negative impacts, such as ecological imbalance, air pollution, and soil degradation, is prevalent, particularly among students and managers. Statistical analysis revealed significant differences in perception and behavior toward straw burning among the groups. Despite the willingness of farmers to adopt sustainable straw management practices, they require low-cost solutions that do not significantly alter their farming practices. This study proposes a policy framework that includes educational initiatives, community participation, and government support to promote sustainable straw management. By guiding farmers away from straw burning, the framework aims to reduce air pollution and contribute to environmental protection and sustainable agricultural development.

KEYWORDS: Open burning, awareness, straw burning, environmental impact, health impact, sustainable agriculture, community health, environmental policy

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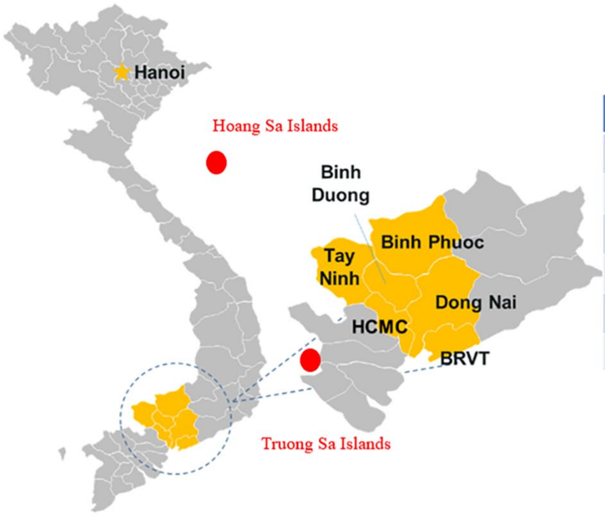
Introduction

Vietnam is the third largest rice exporter, contributing approximately 7 million tons of rice annually to global food security and generating a substantial amount of agricultural by-products.[1-3] It is estimated that the agricultural by-products of straw and rice husk account for approximately 52 million tons per year.[4-6] These by-products can be reused in various fields such as animal feed, fuel, roofing, packaging, fertilizer, and growing substrates. Typically, farmers use these by-products themselves or collect and sell them to intermediaries, who then transfer them to other industries.[7-9] However, the low selling price of by-products, coupled with the high cost of mechanical collection, prompts many farmers to opt for burning straw directly in the fields for quick disposal. The practice of burning fields is not new; it has been around for generations when farmers burn dry grass on the fields. This method is considered inexpensive, helps reduce pests, and is effective in removing crop residues before preparing the land for the next planting season.[10-12] However, burning fields has numerous negative consequences, such as loss of soil nutrients, environmental pollution, and health risks to the community. Outdoor straw burning produces soot and smoke, causing health problems and emitting greenhouse gases such as CO_2, CH_4, NO_x, and SO_x, contributing to global warming; it also results in the loss of essential nutrients such as nitrogen (N), phosphorus (P), potassium (K) and sulfur (S); adversely affects soil properties and wastes valuable carbon.[13-15] Rice straw burning is known to release various harmful pollutants into the atmosphere, contributing significantly to air quality degradation and environmental health risks. Among primary emissions are secondary organic aerosols (SOA_s), phosphine, polycyclic aromatic hydrocarbons (PAH_s), and particulate matter such as PM10 and $PM_{2.5}$.[16,17] During the open burning of rice straw, volatile organic compounds (VOC_s) are released, which undergo atmospheric reactions to form SOA_s. Research by Chanana et al indicates that burning rice straw can result in the formation of SOA_s, with concentrations ranging from 10 to 40 μg per cubic meter (μg/m^3) in the immediate vicinity of the burning sites.[18] These aerosols contribute to the formation of smog and have adverse health effects when inhaled, particularly affecting respiratory and cardiovascular health.[19-21] Phosphine is a toxic gas emitted during the combustion of rice straw.[21,22] Studies have shown that phosphine emissions from burning agricultural residues such as rice straw can reach concentrations of up to 0.5 to 1.5 ng per gram (ng/g) of dry straw burned.[22] This gas can pose health risks, particularly in enclosed spaces or areas with poor ventilation, where it can accumulate to harmful levels.[23] PAHs are a group of hazardous organic compounds formed during incomplete combustion of organic material.[24-26] The burning of rice straw releases significant quantities of PAHs, including known carcinogens like benzo[a]pyrene.[27-30] Quantitative data suggest that the emission factor for PAHs from rice straw burning can range from 5 to 10 mg per kilogram (mg/kg) of dry straw.[31-33] These compounds are of concern due to their persistence in the environment and their potential to cause cancer and other serious health problems after prolonged exposure.[29,34,35] One of the most concerning aspects of rice straw burning is the emission of fine particulate matter, particularly PM_{10} and $PM_{2.5}$.[36] PM_{10} refers to particles with a diameter of 10 μm or less, while $PM_{2.5}$ consists of even finer particles with a diameter of 2.5 μm or less. These particles can penetrate deep into the respiratory system, leading to adverse health effects.[16,37] Studies have reported that burning rice straw can produce PM10 concentrations exceeding 200 μg/m^3 and PM2.5 concentrations exceeding 150 μg/m^3 near burning sites.[18,38] These emissions from rice straw burning not only affect air quality and human health, but also contribute to environmental problems such as climate change and depletion of soil nutrient depletion.[39] Understanding the quantitative characteristics of these pollutants is crucial for developing strategies to mitigate the negative impacts of open straw burning and promote sustainable agricultural practices.[8,17,39] Rice production is an important industry in southeast Vietnam. The adoption of green revolution technologies and high-yield rice varieties has increased both crop yield and crop residues. In recent decades, agricultural mechanization, particularly combined harvesting, has become widespread in the Dong Nai, Tay Ninh and Binh Phuoc provinces of Vietnam. In these areas, the time between rice harvest and the next crop planting is usually very short, and any delay in collecting and cleaning fields negatively affects the new crop season. This forces farmers to quickly burn straw to remove post-harvest residues. Burning fields causes significant damage to the environment, public health, and farmers themselves.

Rice straw has significant potential as a raw material for producing renewable biofuels such as biomethane, biohydrogen, and bioethanol. Recent studies have explored the utilization of rice straw in various biofuel production processes. According to Kumar et al , rice straw anaerobic digestion can yield approximately 250 to 300 cubic meters of biomethane per ton of dry straw under optimal conditions.[40] This biomethane can then be purified and used as a clean fuel for power generation, reducing greenhouse gas emissions and promoting sustainable energy production. In addition to biomethane, rice straw is also a valuable feedstock for biohydrogen production. Through processes such as dark fermentation, rice straw can be converted into hydrogen gas, a clean and renewable energy carrier. Patel et al demonstrated that by optimizing the fermentation process, rice straw can produce up to 30 to 40 liters of biohydrogen per kilogram of volatile solids.[41] This biohydrogen has applications in fuel cells, providing a sustainable and environmentally friendly energy source for various applications, including transportation and power generation.[42-45] These applications highlight the potential of rice straw as a versatile feedstock for producing various forms of renewable energy.[8,44,46] By harnessing this agricultural residue, not only can the environmental impact of straw burning be mitigated, but it can also contribute to the development of a sustainable bioeconomy.[47-49]

Therefore, this study was conducted to assess the awareness of 3 main local groups: farmers, students, and managers. The selection of the 3 sample groups, farmers, students, and local government officials, was crucial to capturing a comprehensive view of straw burning practices and awareness in the studied regions. Farmers were selected because they are directly involved in agricultural practices and are the primary actors in straw burning. Understanding their perceptions, behaviors, and challenges is essential to identify feasible and sustainable alternatives. Students, representing the younger demographic, were included to assess the level of environmental awareness among future generations that will influence and potentially change agricultural practices. Local government officials were chosen for their role in policy making and community engagement, as they have the authority to implement regulations and promote sustainable practices. The objectives of this study were to evaluate the awareness and attitudes of these 3 groups toward straw burning, identify key factors influencing their behaviors, and propose policy interventions to promote sustainable straw management. To achieve these objectives, a stratified random sampling method was used to survey 686 individuals, and data were analyzed using EFA to identify patterns and relationships. The anticipated results included uncovering knowledge gaps, varying attitudes, and practical barriers to adopting sustainable practices.

The study evaluates the factors that lead to straw burning and uses EFA to gain a deeper understanding of the burning behavior in the locality. In this study, we surveyed and analyzed the opinions of more than 600 individuals from the 3 main groups in Dong Nai, Tay Ninh, and Binh Phuoc provinces, Vietnam, key rice producing areas in Vietnam. The results of the survey indicate that farmers are willing to abandon straw burning and adopt sustainable straw management methods to increase income, protect the environment, and protect their health and that of the community. However, they require solutions to be cost-effective and do not significantly alter their current farming practices. This study provides important suggestions for policymakers, helping them prioritize investments and design optimal policies to minimize air pollution. We emphasize the shift from straw burning to sustainable straw



No.	Province	Population (2022)	Area (km^2)
1	Tay Ninh	1,188,760	4,041.65
2	Binh Phuoc	1,034,670	6,873.56
3	Dong Nai	3,255,810	5,863.62
4	Ba Ria - Vung Tau	1,178,700	1,982.56
5	Binh Duong	2,763,120	2,694.64
6	Ho Chi Minh City	9,389,720	2,095.39

According to international conventions, the Hoang Sa Islands (Hoàng Sa) and the Truong Sa Islands (Trường Sa) are under the sovereignty of Vietnam.

Figure 1. Map of the study area.

management activities, thus contributing to environmental protection and promoting sustainable agricultural development.

Materials and Methods

Study area

The Southeast region is the most economically developed area in Vietnam, contributing more than two-thirds of the annual state budget.[50-52] In addition to its strong industrial growth, this region is also a major rice producing center, providing approximately 2 million tons of rice annually for export.[53-56] Ho Chi Minh City, Ba Ria-Vung Tau, and Binh Duong are the top 3 localities in the region that attract the most industrial investment. Meanwhile, the 3 provinces of Tay Ninh, Binh Phuoc, and Dong Nai continue to develop agriculture alongside industry, contributing a substantial amount of agricultural products. Therefore, in the direction of sustainable agricultural economic development, this study was carried out in the 3 provinces of Tay Ninh, Binh Phuoc, and Dong Nai in the Southeast region of Vietnam, which respectively account for 17%, 29% and 25% of the area (Figure 1).[56,57] These provinces are the main rice producers of the country, contributing to national food security. The presence of major national highways, such as National Highway 1A, National Highway 20, and National Highway 22 in the region plays an important role in facilitating sustainable agricultural development. These highways enhance connectivity between rural agricultural areas and urban markets, reducing transportation costs and ensuring efficient movement of goods.[58,59] This accessibility allows farmers to transport their produce, including sustainably managed straw and other agricultural by-products, to markets more efficiently. As a result, farmers can adopt sustainable practices such as straw recycling, composting, and alternative uses of crop residues, knowing they have reliable access to markets for these products.[60] Furthermore, improved infrastructure encourages the development of agroprocessing industries along these highways, providing farmers with additional revenue streams and supporting the local economy.[61,62]

Agricultural development in this region has the potential to serve as a model for local economic development by demonstrating the economic benefits of sustainable practices.[63,64] By adopting sustainable straw management methods, such as using straw for bioenergy production, animal feed or organic fertilizers, farmers can create a circular economy that maximizes resource use while minimizing environmental impact.[65-68] This not only promotes environmental sustainability, but also improves farmers' income and livelihood. The integration of sustainable agriculture with agroprocessing industries along the highways can lead to job creation, technology transfer, and skill development in rural communities. Consequently, this holistic approach can stimulate local economic growth, reduce rural poverty, and serve as a replicable model for other regions seeking to balance economic development with environmental stewardship.

Study work

In this study, we used survey methods that included questionnaires, direct interviews, and data analysis. The questionnaires were initially prepared in Vietnamese and then translated into English for the evaluation of the discussion content. This study conducted 686 surveys in 3 main groups: farmers, managers and high school students, to collect awareness data. The questionnaires included information on the current situation, farmers' knowledge about straw burning, the factors behind the practice, and its impacts on soil quality, health and the environment. Direct interviews provided detailed information on the perspectives of farmers, managers and students on straw burning and their level of awareness. From these data, we used analytical methods to assess the factors that influence this behavior. The purpose of the study was clearly explained to the participants, who gave their verbal consent to participate in the study.

The confidentiality of the collected data was strictly maintained throughout the research period.

The survey process in this study focuses on representative communes in 3 provinces. Tay Ninh, Dong Nai, and Binh Phuoc. We employ 2 main survey methods:

- *Participatory Rural Appraisal (PRA) Method*: This method was used to investigate the farming practices of farmers and the status of straw burning in the locality. It helped to gather detailed and specific information on the farming behaviors of farmers.
- *Field survey method*: Based on local secondary information and data, we conducted a direct data collection from individual farmers or those engaged in agricultural activities. Although this method of data collection is time-consuming and costly, it provides the most objective and accurate information on the current situation.

The field survey process involved a personal and engaging approach in which each household was visited individually. During these visits, the interviewers used everyday stories and relatable examples to connect with the farmers. This storytelling approach was not only a means of gathering the required information, but also served to build trust and create a comfortable environment for the interviewees. Using this method, farmers felt at ease, which encouraged them to openly share their experiences, perspectives, and practices related to straw burning. This approach was crucial in obtaining honest and detailed responses, leading to a more comprehensive understanding of the attitudes and behaviors. After data collection, we analyze the results to identify any anomalies and ensure the accuracy and reliability of the data. This information serves to evaluate and investigate straw burning and the straw management methods in the locality.

Data analysis and processing

The study used a stratified random sampling method to ensure a diverse and representative sample of 3 key groups: farmers, students, and managers. We focus on the major rice-producing provinces of Tay Ninh, Binh Phuoc, and Dong Nai to capture a wide range of opinions on straw burning practices. The final sample comprised 686 individuals, including 349 farmers, 250 students, and 87 local government officials. Farmers were selected based on their active participation in rice production in these provinces, with inclusion criteria ensuring that participants were directly involved in agricultural practices. Students were randomly chosen from local high schools to represent the awareness and perspectives, while managers included local officials such as agricultural officers, village heads, and land administration staff, selected based on their roles in community and agricultural management. Data were collected through structured surveys, interviews, and evaluations. The surveys assessed participants' awareness, attitudes, and behaviors related to straw burning. Direct interviews with farmers and managers provided detailed insights into their practices and decision-making processes, while student evaluations focused on their environmental awareness and observations of agricultural activities. In addition, we incorporated information from local media sources, including news outlets, government reports, and agricultural bulletins, to provide a comprehensive context for the survey findings. This approach ensured a balanced and comprehensive representation of the stakeholders' perspectives on straw burning in Southeast Vietnam

Data in this study were collected through surveys, evaluations, and evaluations from residents, local officials, and sources of the public media. The collected data was processed using SPSS (Statistical Package for the Social Sciences), a powerful computer tool for statistical work. SPSS supports the processing and analysis of primary data, which is information collected directly from research subjects.[69]

Exploratory factor analysis (EFA) methodology

The survey items and scales used in this study were carefully selected based on a comprehensive review of the existing literature on straw burning practices, environmental awareness, and agricultural behaviors. The elements were designed to measure key constructs, including knowledge of environmental impacts, perceived economic benefits of straw burning, and willingness to adopt alternative practices. Exploratory factor analysis (EFA) was employed to identify underlying patterns within the data and validate these constructs. Cronbach's Alpha was utilized to assess the internal consistency of each construct. Although some constructs exhibited marginally acceptable reliability scores (slightly below the conventional threshold of 0.70), these were retained due to their theoretical significance and relevance to the research objectives. The decision to include these constructs was based on the complexity of the factors that influence straw burning behaviors and the need to provide a nuanced understanding of these dynamics. The inclusion of these elements, even with marginal reliability scores, allows for a more comprehensive exploration of the factors at play, acknowledging the multifaceted nature of the issue. The EFA findings supported the robustness of these constructs, revealing consistent patterns that align with theoretical expectations.

The analysis and evaluation process in this study comprises 4 main steps to ensure the precision and reliability of the results[70-72] as shown in Figure 2:

- *Step 1*: Reliability testing of the questionnaire scale, the initial step involves testing the reliability of the questionnaire scale using Cronbach's Alpha. This is a common method to determine the internal consistency of the items in the questionnaire, ensuring that all questions measure the same concept.
- *Step 2*: The study then performs EFA. This method helps identify the latent structure of the dataset, reducing the

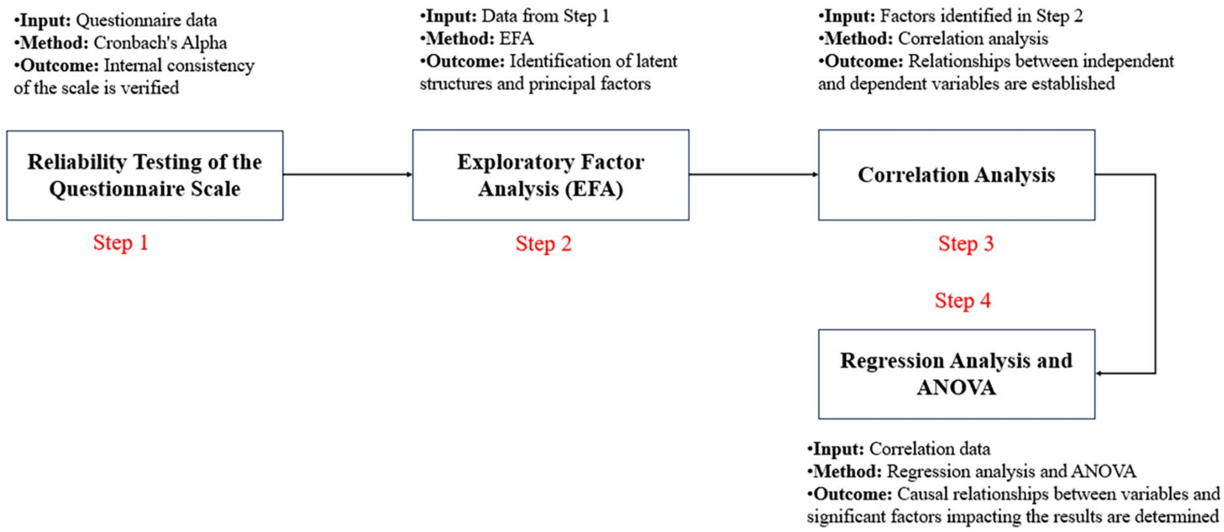


Figure 2. The analysis and evaluation process in this study.

number of observed variables by grouping related variables into principal factors. EFA helps to explore and identify the main aspects of the research problem.

- *Step 3*: Correlation analysis, research performs correlation analysis between variables. This method helps determine the relationships between independent and dependent variables, providing a better understanding of the connections and influences among the factors in the study.
- *Step 4*: Regression analysis and ANOVA, in the final step, the study uses regression ANOVA to examine the causal relationships between variables. Regression analysis helps determine to what extent independent variables affect the dependent variable, while ANOVA compares the differences between groups and identifies which factors significantly impact the research results.

These analytical steps not only ensure the scientific rigor and accuracy of the study but also provide detailed and in-depth insights into the research problem. This, in turn, leads to valuable practical conclusions and recommendations.

Reliability testing of the questionnaire scale. To ensure the precision and reliability of the data in this study, we employed reliability testing methods such as Cronbach's Alpha (α) and Item-total correlation, based on the scale evaluation standards of Nunnally and Bernstein.[73] According to these standards, a scale is considered acceptable when Cronbach's Alpha falls within the range of $.6 \leq \alpha \leq .95$. If $\alpha > .95$, there is redundancy between the items, which reduces the reliability of the scale. On the contrary, if $\alpha < .3$, the items are deemed unreliable and should be removed. Additionally, the item-total correlation must be greater than 0.3 to ensure that the items are closely related to the overall scale. Cronbach's Alpha is used to evaluate the reliability of the scale by checking the internal consistency of the items.[74,75] This analysis helps determine whether the observed variables consistently measure a specific concept. Items with low item-total correlation are eliminated to avoid creating spurious factors during EFA. In this study, we applied Cronbach's Alpha to assess the reliability of each scale and examine the appropriateness of each item. The goal is to ascertain whether the observed variables genuinely measure the same concept. After eliminating unsuitable variables through Cronbach's Alpha analysis, we proceeded with EFA to identify the latent structure of the data. Using Cronbach's Alpha and Item-Total Correlation, we ensured the scientific rigor and reliability of the study, providing accurate and practically valuable results.

In this study, independent variables include factors such as participant demographics, awareness of straw burning practices, perceived benefits and drawbacks of straw burning, and willingness to adopt alternative methods. The dependent variable is the overall behavior or attitude toward straw burning, which reflects whether individuals continue to burn straw or are willing to adopt sustainable management practices. By identifying these variables, the study aims to explore how various factors influence attitudes and behaviors related to straw burning.

Exploratory factor analysis (EFA). The input for the EFA in this study is the survey responses collected from the 3 groups (farmers, students, and local government officials). These responses were structured to capture the views on straw burning across multiple dimensions, such as environmental impact, health risks, agricultural benefits, and economic considerations. The results of the EFA include the identification of latent factors that underlie the observed variables, such as key beliefs or attitudes that influence straw burning behaviors. These factors provide insight into the key elements driving the decision-making process regarding straw management.

EFA is a method used to reduce a set of k observed variables into a smaller set of more meaningful factors F (where $F < k$). In this process, Varimax rotation is often used to improve the interpretability of factors.[76-78] During research, a large number of observed variables are typically collected, many of which are correlated. Instead of studying 20 minor characteristics of an object in detail, we can focus on 4 major characteristics, each encompassing correlated minor characteristics. This approach saves time and research costs. While Cronbach's Alpha assesses the relationship between variables within the same group or factor, EFA examines the relationships between variables between different groups of factors, helping to identify observed variables that are loaded onto multiple factors or are incorrectly assigned to initial factors.

In the EFA conducted in this study, k refers to the number of factors extracted from the data set. The determination of k was based on criteria such as eigenvalues greater than 1 and the scree plot, which helped identify the optimal number of underlying factors within the data. The initial analysis considered 20 minor characteristics, which were specific survey items that addressed various aspects, including demographic details, environmental awareness, perceived benefits and drawbacks of straw burning, and openness to sustainable practices. These 20 variables were examined to uncover patterns and correlations, allowing for a reduction in the data complexity. Through the EFA process, these variables were grouped into 4 major characteristics or latent factors, which represent the core dimensions that influence attitudes and behaviors toward straw burning. These main characteristics provide a more concise understanding of the primary drivers identified in the study, providing insight into the key aspects that shape the views and actions related to straw management. The key criteria in EFA include[77,79,80]:

- *Kaiser-Meyer-Olkin (KMO) measure*: This index assesses the suitability of factor analysis, with values ranging from 0.5 to 1. The higher the KMO value, the more suitable the data for factor analysis.
- *Bartlett's test of sphericity*: This test checks whether the observed variables within a factor are correlated. If this test is statistically significant (Sig. < 0.05), the observed variables are correlated in the population.
- *Total variation explained*: This index must reach $< 50\%$, indicating that the EFA model is appropriate. It represents the percentage of variance in the observed variables that is condensed by the factors.
- *Factor loading*: This indicates the correlation relationship between an observed variable and a factor. According to Hair et al, the factor load value ensures the practical significance of EFA[81]:

  + Factor Loading > 0.3 is considered the minimum acceptable level.
  + Factor Loading > 0.4 is considered important.
  + Factor Loading > 0.5 is considered practically significant.

The EFA must satisfy the following conditions[81]:

+ The KMO coefficient should be in the range of 0.5 KMO 1.
+ The Bartlett test for sphericity should be statistically significant (Sig. < 0.05).
+ The highest factor loading of each observed variable should be 0.5.

The application of EFA simplifies and condenses the data, leading to valuable and practical insights and conclusions while conserving research resources. EFA was applied to understand the complex relationships between the independent variables and to identify the latent factors that influence the behavior of straw burning. The analysis aimed to reduce the number of variables to a smaller set of factors that explain the variation in participants' attitudes and practices. Rather than providing a general explanation of EFA, this section emphasizes how EFA was specifically utilized in this research. For example, EFA helped uncover underlying patterns in the attitudes of farmers, students, and local government officials toward straw burning. This analysis facilitated a deeper understanding of the different perspectives and how they contribute to the overall problem. When focusing on the specific use of EFA in this study, the discussion becomes more concise and directly related to the research objectives and findings.

Correlation analysis. In the analysis applied to this study, Pearson's correlation coefficient test is used to examine the linear relationship between independent and dependent variables. If the independent variables are highly correlated with each other, multicollinearity issues must be considered when conducting a regression analysis (null hypothesis H_0: correlation coefficient equals 0).[82,83] The Pearson correlation coefficient between 2 variables x and y from n samples is estimated using formula (1). The results of Pearson's correlation analysis indicate that some independent variables are correlated with each other.[83] Therefore, when performing regression analysis, it is crucial to pay particular attention to the issue of multicollinearity. The Pearson correlation coefficient provides insight into the strength and direction of the linear relationship between variables. High correlations among independent variables can distort the results of regression analysis, making it difficult to determine the individual effect of each variable. Therefore, identifying and addressing multicollinearity is essential for accurate and reliable regression modeling.

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}} \tag{1}$$

Multicollinearity occurs when independent variables are highly correlated with each other, which can weaken the explanatory power of the regression model and lead to inaccurate results. In this case, independent variables that are correlated with the dependent variable will be included in the regression model to explain the dependent variable, but measures to test and adjust for multicollinearity are necessary to ensure the model's accuracy. These measures can include the use of multicollinearity diagnostic indicators such as the Variance Inflation Factor (VIF) and Tolerance, or the application of alternative regression methods such as Ridge Regression or Lasso Regression to mitigate the effects of multicollinearity.[84,85] Therefore, Pearson's correlation analysis is a crucial step in identifying the relationships between variables in the constructed study and ensuring that the regression model is accurate and reliable.

To ensure the validity of the regression analysis, we examined the potential issue of multicollinearity among the independent variables. Multicollinearity occurs when independent variables are highly correlated, potentially distorting regression results and undermining the study findings. To assess this, we calculated the variance inflation factor (VIF) for each independent variable included in the regression models. The VIF values ranged from 1.2 and 3.8, all of which are well below the commonly accepted threshold of 5. These results indicate that multicollinearity was not a significant concern in our analysis. By confirming the absence of high multicollinearity, we ensured that the regression coefficients accurately represent the relationship between the independent variables and the dependent variables. This analysis strengthens the validity of our findings, allowing us to draw meaningful conclusions about the factors influencing straw burning practices.

Regression and ANOVA analysis. Regression analysis is used to model the relationship between a dependent variable and 1 or more independent variables. There are various types of regression, such as logistic regression and polynomial regression, but in this study, we focus solely on linear regression. Linear regression is a statistical method used to regress data when the dependent variable has continuous values, while the independent variables can have continuous or categorical values.[86] In other words, linear regression is a method for predicting the dependent variable (Y) based on the values of the independent variables (X). This method is commonly used when we want to predict a continuous quantity.

During linear regression analysis, the study will obtain results such as variance (σ^2) to evaluate data spread, standard deviation (σ), which is the square root of variance, normal distribution, and error (actual value minus predicted value). Additionally, ANOVA is used to test the differences between categorical and continuous variables.[87] For example, ANOVA can test whether there is a difference in customer satisfaction with bank A between different customer groups (based on gender, age, and income level). To do this, we conduct ANOVA and an independent sample T-test. Statistical significance is considered at a 95% confidence level (Sig. < 0.05). There are 2 types of variance analysis: One-way ANOVA and multivariate ANOVA.[88] In this study, we only used 1-way ANOVA. When conducting a 1-way ANOVA, we interpret results from 2 tables:

- ***Test of homogeneity of variances*:** Levene's test to determine the homogeneity of variances.
- ***ANOVA table*:** Test the differences between groups of categorical variables.

Using linear regression and ANOVA helps us better understand the relationships between variables and test differences between groups, providing accurate and practically valuable conclusions.

Sample evaluation and minimum Sample Selection

In this study, we did not survey all units of the population, but focused only on certain units due to limitations in cost, time, and effort. Therefore, the research relies on the characteristics and properties of the survey sample to infer the characteristics and properties of the entire population. The survey subjects were divided according to different households to ensure representativeness. The minimum sample size to achieve reliability for the study was determined using a mandatory formula, based on the requirements of the EFA.

$$\mathbf{N}\ (\textbf{total sample}) = 5 \times m \tag{2}$$

In this context, m is the number of questions about the factors surveyed. This formula is based on the research by Hair et al,[81] which suggests that the minimum sample size should be 5 times the total number of variables observed for the independent factors. This is an appropriate sample size for studies using factor analysis.[89,90] In this study, the survey questionnaire includes a total of 18 questions related to the impacts on straw burning behavior. Therefore, the minimum total survey sample size will be: $18 \times 5 = 90$. Therefore, the necessary number of survey responses for the 3 groups, farmers, managers, and high school students, should be at least 90. The responses of these subjects will ensure the suitability and reliability of the study.

Results and Discussion

Survey questionnaire and interview details

The survey questionnaire was carefully designed and divided into 3 main parts to capture a holistic view of the participants' awareness, attitudes, and behaviors regarding straw burning practices.

- **Part 1: Demographic Information:** This section collected essential background data from each participant, including age, sex, education level, occupation, and farm experience (for farmers). For farmers, specific questions were included about the type of crops they grow and the size of their agricultural land. For students, information about their grade level and family history in agriculture was gathered. Local government officials were asked about their roles and responsibilities in managing agricultural practices. This demographic information was crucial to understanding the diversity of the sample and analyzing differences in perceptions and behaviors between various groups.

- **Part 2: Knowledge and Perceptions of Straw Burning:** This section aimed to assess participants' awareness of the environmental and health impacts of straw burning. The questions explored their understanding of the consequences of open burning, such as air pollution, soil degradation, and health risks. It also delved into the participants' beliefs about the perceived benefits of straw burning, including pest control and soil fertilization. The questions in this part used a Likert scale format, allowing respondents to express the extent of their agreement or disagreement with statements related to straw burning. This section also assessed the participants' awareness of sustainable straw management practices, such as composting, mulching, and bioenergy production. The average value of the responses of the Likert scale was calculated to determine the central tendency of the participants' attitudes toward each statement. To compute this average, the numerical values assigned to each response option on the 5-point Likert scale (1 = "Strongly Disagree," 2 = "Disagree," 3 = "Neutral," 4 = "Agree," and 5 = "Strongly Agree") were summed for all respondents. This sum was then divided by the total number of respondents for that specific statement. For example, if a particular statement was rated by 100 participants, the individual scores for that statement were totaled and then divided by 100. This resulting mean score provides an overall indication of the group's collective stance on the statement, offering insights into their attitudes or perceptions. Using this method, we were able to quantify and analyze the general trends in the survey data effectively.
- **Part 3: Behaviors, Practices, and Openness to Alternatives** This final section investigated the current practices related to straw management among participants. For farmers, it included questions on the frequency of straw burning, the methods they use, and the challenges they face when adopting alternative practices. The students were asked about their observations about straw burning in their communities and their participation in any environmental activities. Local government officials provided information on their role in regulating and promoting sustainable practices. Additionally, this section explored the participants' willingness to adopt sustainable straw management alternatives, including their willingness to participate in training programs and implement new practices.

Table 1. Types of crops cultured in the survey sample.

CROP	NUMBER OF CULTIVATIONS	PERCENTAGE OF TOTAL SAMPLE (%)
Rice	159	45.6
Corn (maize)	37	10.6
Vegetables	22	6.3
Pomelo	20	5.7
Durian	58	16.6
Mangosteen	6	1.7
Rambutan	29	8.3
Mango	21	6.0
Longan	3	0.9
Pineapple	3	0.9
Tea	3	0.9
Coconut	32	9.2
Cashew	56	16.0
Sugarcane	7	2.0
Pepper	25	7.2
Cacao	4	1.1

In addition to the structured survey, semi-structured interviews with farmers and local government officials were conducted to gain deeper insights into their experiences and perspectives. The interviews included open-ended questions tailored to each group. For farmers, the questions focused on the practical challenges they face in adopting sustainable straw management practices, their economic considerations, and their interactions with local policies and support programs. Interviews with local government officials explored their role in implementing agricultural policies, the effectiveness of existing regulations, and their views on the potential for community training and support programs to promote sustainable practices.

This combined approach of using both surveys and interviews allowed for a comprehensive exploration of attitudes and behaviors related to straw burning, providing a rich data set for analysis. By incorporating both quantitative data from surveys and qualitative insights from the interviews, the study aimed to capture the complexity of the issue from multiple perspectives, inform targeted interventions and policy recommendations.

Characteristics of representative individuals

Farmers. Table 1 presents statistics on the types of crops cultivated by the farmers surveyed. The survey results indicate that rice is the most commonly grown crop in the 3 surveyed provinces, accounting for 45.6%, equivalent to 159 survey responses. Other fruit crops are also grown in these areas, each type having a percentage below 17%. Perennial industrial crops such as cashew, pepper, and cacao occupy a lower percentage, below 16%.

Figure 3A and B present the results of the survey on the age and years of farming experience of the farmers participating in the study. The results indicate that the main labor force is primarily concentrated in the age range of 30 to over 60 years, with the age range of majority in the 45 to 60 years, accounting for 35.1%. Farmers 60 and older and those aged 30 to 45 years constitute 31.4% and 26.8%, respectively, ranking second and third in the survey. Other age groups, such as 24 to 29, account for 5.8%, and those under 23 years of age represent less than 1%. Furthermore, most farmers have over 20 years of farming experience, making up 39.9%. The distribution of years of experience is as follows: 11% (5-10 years), 20.7% (10-15 years), 11% (15-20 years), and less than 5 years account for less than 10%. This shows that the main labor force consists of middle-aged and old farmers. Of the 686 survey responses, 349 belong to farmers, representing 50.9% of the total survey. Among these, men farmers make up 62.4% (181 individuals), while women farmers account for 37.6%.

Figure 3C and D provide information on the size of the household and the number of primary laborers in the farmer's family. The results show that most families have 1 to 3 members and 4 to 6 members, representing 30.1% and 64.1%, respectively. Families with 7 or more members only make up about 5.8%. The highest number of primary laborers in each family is 2, which is 47.4%. Families with 1 to 4 primary laborers account for less than 20%, and those with more than 5 laborers make up about 6.5%. This indicates a significant disparity in the number of primary laborers between farm households.

The survey on the level of education of the primary laborer and the highest educational attainment in the family (Figure 3E and F) shows that the primary laborers in farmer households have a mainly secondary education, accounting for 53.4%. Farmers with primary education make up 17.7% and those without any formal education 16.2%. The proportion of farmers with college and university degrees is very low, only about 12.8%. The highest educational attainment in the family among the surveyed households is primary education, accounting for the highest percentage at 51.9%. Family members with college and university degrees account for less than 35%, corresponding to 19.3% and 12.9%, respectively. Family members with secondary education and those without formal education represent 95% and 6.3%, respectively, indicating that most farmers' households have at least a primary education level.

Although the survey results suggest a general willingness among farmers to adopt sustainable practices, it is essential to consider the economic, social, and practical barriers that may impede this transition. A significant barrier is the economic cost associated with implementing alternative straw management methods, such as purchasing composting equipment or bioenergy production systems. Many farmers operate on tight profit margins and may find it challenging to invest in these alternatives without financial support or subsidies. In addition, social factors such as long-standing cultural practices and community norms can influence farmers' decisions. In many rural communities, straw burning is seen as a traditional and efficient method of managing agricultural residue. Changing these ingrained behaviors requires not only education, but also community-based initiatives that demonstrate the benefits of sustainable practices. Additionally, there are practical barriers, such as lack of technical knowledge and access to appropriate technology. Farmers may need ongoing training and support to effectively adopt new methods such as composting or bioenergy production. These complexities highlight that while there is a willingness among farmers to consider sustainable options, a holistic approach addressing economic incentives, social influence, and practical support is crucial to facilitate this transition. Therefore, our study calls for comprehensive strategies that include financial incentives, community engagement, and capacity building programs to overcome these barriers and promote the adoption of sustainable straw management practices.

In summary, the personal characteristics collected in the survey sample, including occupation, age, educational attainment, and household size, contribute to a more objective evaluation of the analysis results. Information from the representative individual characteristics that responded to the survey demonstrates that the study's survey data are reliable for subsequent analyzes.

High school students. Of a total of 686 survey responses, 250 were collected from high school students, which represented 36.4% of the survey. Among these, only 20 responses were from 11th grade students, making up 8.3%, while the remaining 91.7% were from 12th grade students. The gender distribution in the sample is fairly balanced, with 43.6% of male respondents and 56.4% of female respondents.

Identifying family composition based on the main occupation of the surveyed students' families provides important insights into the economic and social context of these households. Figure 4 presents the survey results regarding the main occupation that provides income for the students' families. The results show that farming households make up the highest proportion, 41.1%, indicating that most of the students come from agricultural families, reflecting the predominant economic characteristic of the area surveyed. Freelance work accounts for 39.8%, showing a significant proportion of families derive income from non-fixed jobs or occupations not classified into specific categories, including small-scale trading, services, or seasonal labor. A small number of families, making up 0.4%, engage in other unspecified occupations. Additionally, households that operate their own small businesses account for 6.5%, reflecting the presence of small-scale business activities such as handicrafts, food processing, or other types of enterprises. The

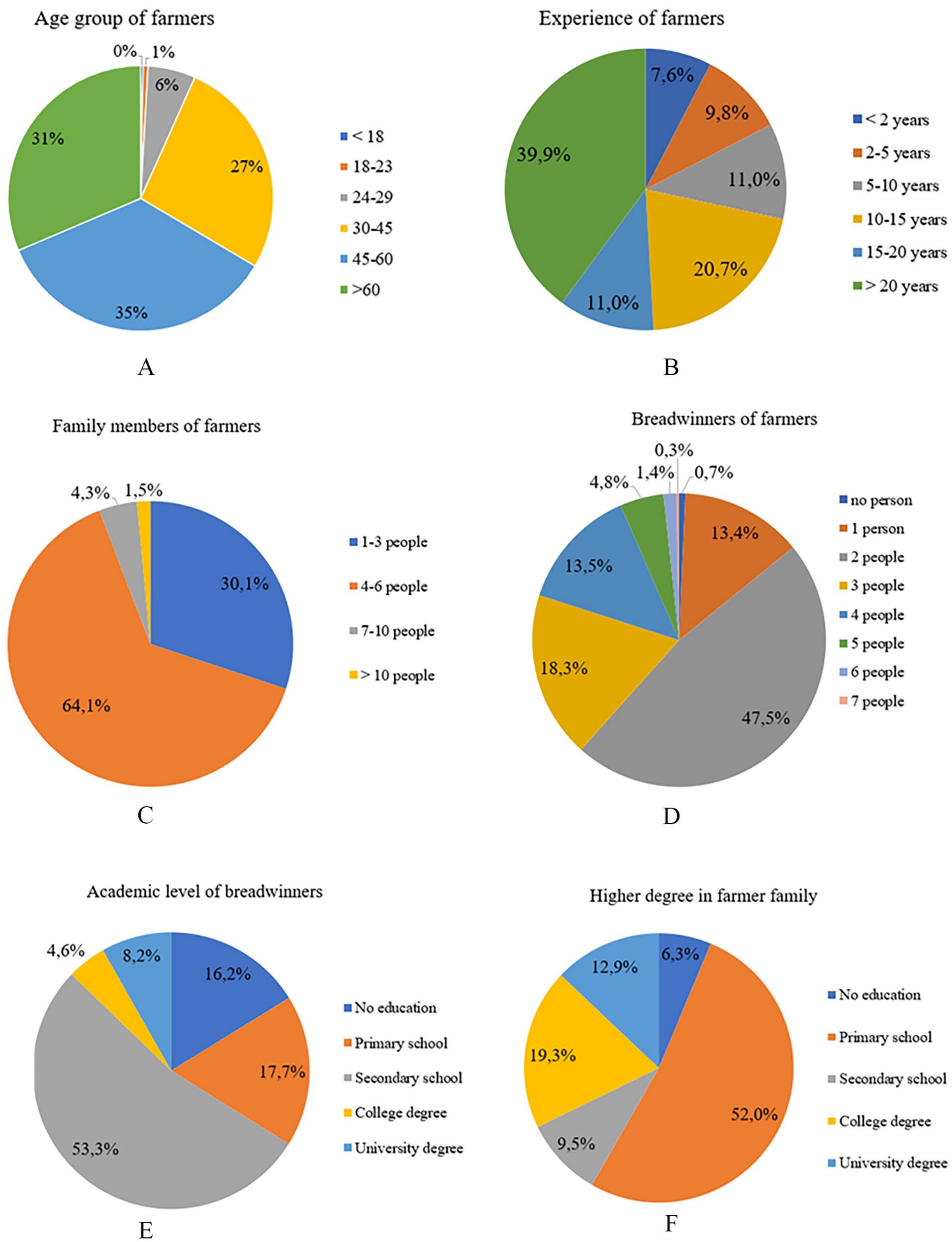


Figure 3. Information on (A) age, (B) years of farm experience, (C) household size, (D) number of primary laborers in the family, (E) education level of the primary laborer, and (F) highest educational attainment in the farmer family.

number of workers is 2.8%, indicating a small proportion of families whose main income comes from industrial or manufacturing labor. Government employees in this sample account for 9.4%, indicating the presence of families with income from public sector jobs, such as teachers, administrative staff or positions in government agencies.

In general, although the occupational composition of the families is quite diverse, most of them are engaged in

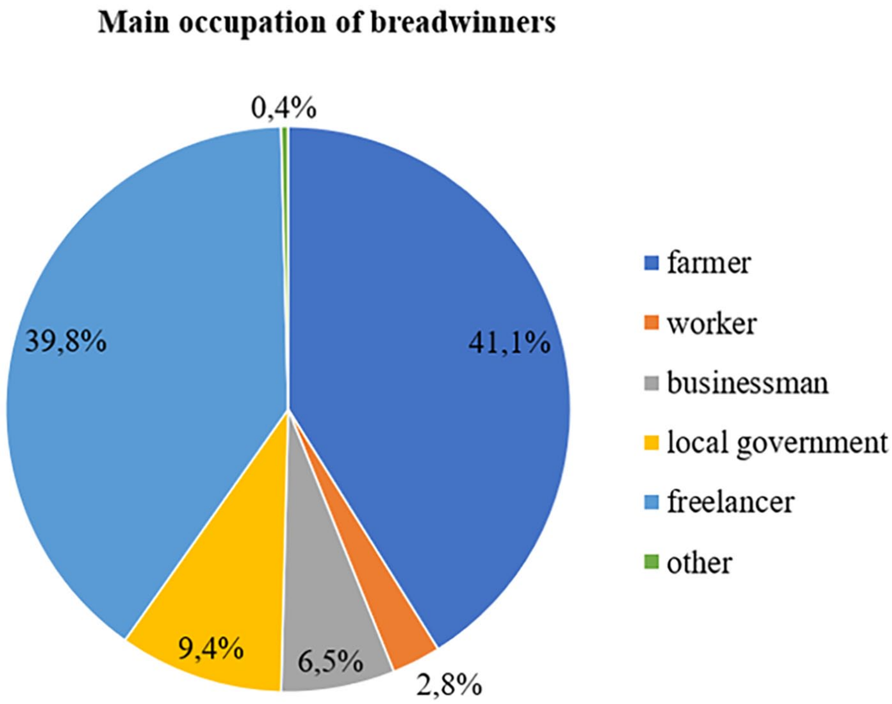


Figure 4. Main occupation providing income for families.

agriculture. This suggests that the sample is suitable for exploring issues related to straw burning and open burning, as agricultural families are likely to be directly involved in these activities. The diverse occupational composition also allows the study to gain a comprehensive view of differences in perceptions and behaviors related to straw burning in different occupational groups, thus providing appropriate recommendations and solutions for each group.

Local government officials. Although data collected from farmers and students provided a detailed understanding of straw burning practices and perceptions, the role and knowledge of local government officials also merit deeper exploration. The survey results indicate that local government officials have a foundational understanding of the environmental and health impacts of straw burning. However, their degree of knowledge varies, and some officials demonstrating a more comprehensive grasp of sustainable agricultural practices than others. Despite this variability, most officials recognized the need for intervention and policy measures to mitigate straw burning. Their role is crucial, as they are positioned to influence policy implementation, enforce regulations, and lead community education initiatives. However, the findings also suggest that these officials need further training to effectively fulfill their responsibilities in promoting sustainable practices. Enhancing your knowledge base through capacity-building programs can empower you to guide the farming community toward adopting alternative straw management methods. Therefore, a strategic approach that includes developing the expertise of local government officials should be a key component of efforts to raise awareness and implement sustainable agricultural policies.

The inclusion of local government officials in this study aimed to evaluate their awareness and potential role in raising community knowledge and providing training on sustainable straw management practices. This group consisted of 87 individuals, including agricultural officers, village heads, and land administration staff, who are actively involved in local agricultural policies and practices. Although the study identified the need for increased training and awareness-raising initiatives among farmers, it is important to note that the research mainly focused on assessing current awareness levels and attitudes rather than implementing training programs. Therefore, while the officials surveyed recognized the importance of such initiatives, the study did not conduct training sessions but rather provided recommendations for future policy and educational interventions to improve sustainable practices and reduce straw burning.

Of a total of 686 survey responses, 87 were collected from local government officials, representing 12.7% of the survey. Information about these officials focuses on their job positions and local solutions related to straw burning and the use of pesticides. The job positions include: Party Secretary, Village Head, Civil Servant in Land Administration, Agriculture, Construction, and Environment, Chief and Deputy Chief of Commune Police, Judicial Officer, Chairman of the Vietnam Fatherland Front Committee, Village Farmers' Association Head, Chairman and Deputy Chairman of the Farmers' Association and Women's Union, and Cooperative Management Board members. The diversity in job positions among these officials provides a comprehensive perspective on the potential to support farmers in adopting new perspectives on straw burning. Each position offers specific insights and understanding of different aspects of the issue. For example, land administration and agricultural civil servants can provide detailed information on planning and agricultural technical measures, while judicial officers can help enforce environmental protection regulations.

The proposals of these officials include the organization of training sessions to increase awareness and skills in sustainable farming practices, thus reducing field burn. They can also suggest technological improvements to more efficient straw management, such as the use of biological products or modern agricultural machinery. Additionally, collaboration between stakeholders such as Farmers' Association, Women's Union, and agricultural cooperatives plays a crucial role in implementing and monitoring these solutions. Consulting local officials ensures that the proposed solutions are not only theoretical, but also practical and suitable for local conditions. This improves the feasibility and effectiveness of the proposed measures. Through close cooperation between stakeholders, this study aims to create practical and sustainable measures to address straw burning and pesticide use, thus contributing to environmental protection and improving the living conditions of local residents.

The local government officials' group provided valuable insight into the complexities of implementing sustainable straw management practices. The survey revealed that while these officials are generally aware of the negative environmental and health impacts of straw burning, there is a gap between awareness and action. Many officials acknowledged the challenges in enforcing regulations and promoting alternative practices among farmers, citing factors such as limited resources, lack of farmer incentives, and the need for cost-effective solutions. Despite these challenges, this group expressed a willingness to support educational initiatives and policy development to reduce straw burning. However, the findings also highlighted the need for enhanced training and capacity building programs for officials themselves. By improving their knowledge and skills, these local leaders could more effectively advocate for and implement sustainable practices at the community level. This suggests that, while local government officials play a crucial role in raising awareness and guiding policy, a concerted effort is required to bridge the gap between awareness and practical action. Future interventions should focus on equipping these officials with the tools and knowledge to lead community-based training programs and support the adoption of alternative straw management methods.

Evaluation of the current status of straw burning behavior in the local area

Figure 5 presents the results on the frequency of straw burning among farmers who participated in the survey. With more than 270 responses on the frequency of direct straw burning, the results show that 153 farmers reported "never" burning fields, which is 55.2%. The responses indicating infrequent burning included 66 responses, equivalent to 24.4% (7.9% every 2 years and 15.9% once a year). This indicates that a relatively high percentage of farmers have participated in straw burning at least once. In particular, the frequency of burning "3 times a year" and "twice a year," corresponding to the 3 rice harvests annually, had 37 and 21 responses, representing 13.4% and 7.9%, respectively. This means that 21.3% of the total survey responses reflect frequent straw burning. These results align with the survey on cropping patterns (Table 1), showing that rice cultivation accounts for 45.6% of the total survey sample, while other cropping types, mainly fruit trees, have less straw burning behavior.

Figure 6 analyzes the actions of the students with respect to the current state of straw burning. The results show that the frequency with which students observe straw burning on a Likert scale is an average of 2.81 ± 0.077, indicating that students occasionally see straw burning in their area. If their families participate in straw burning, the students also provide support, but the level of support is minimal and rarely occurs, with an average value of 2.05 ± 0.067. Overall, according to statistical results, direct participation in straw burning or supporting family members in this activity is not common among students. This finding is consistent with the current situation, where the issue of straw burning has improved and occurrences of straw burning are infrequent in local areas, limiting students' exposure to this behavior.

In summary, straw burning still occurs in local areas after each harvest season with a moderate frequency. This information is crucial to evaluating the factors that influence this behavior, thus opening up directions for finding suitable solutions to develop plans to limit straw burning.

Analysis of factors influencing straw burning in the research model

Figure 7 employs a 5-point Likert scale to quantify the attitudes and perceptions of the respondents toward various aspects of straw burning and sustainable agricultural practices. The scale is defined as follows: **1** represents "Strongly Disagree," indicating a strong negative response to the statement; **2** stands for "Disagree," reflecting a moderate negative response; **3** is "Neutral," indicating neither agreement nor disagreement with the statement; **4** corresponds to "Agree," showing a moderate positive response; and **5** signifies "Strongly Agree," indicating a strong positive response to the statement. This scale was selected for its ability to capture the nuances of respondents' opinions, allowing for a more nuanced analysis of their attitudes toward straw burning. Each statement assessed using this scale was carefully crafted to explore key dimensions such as environmental awareness, perceived benefits of straw burning, and willingness to adopt sustainable practices. By including this detailed scale definition, we aim to enhance the clarity and interpretability of the data presented in Figure 7, ensuring that readers understand the spectrum of responses and their implications for the study findings.

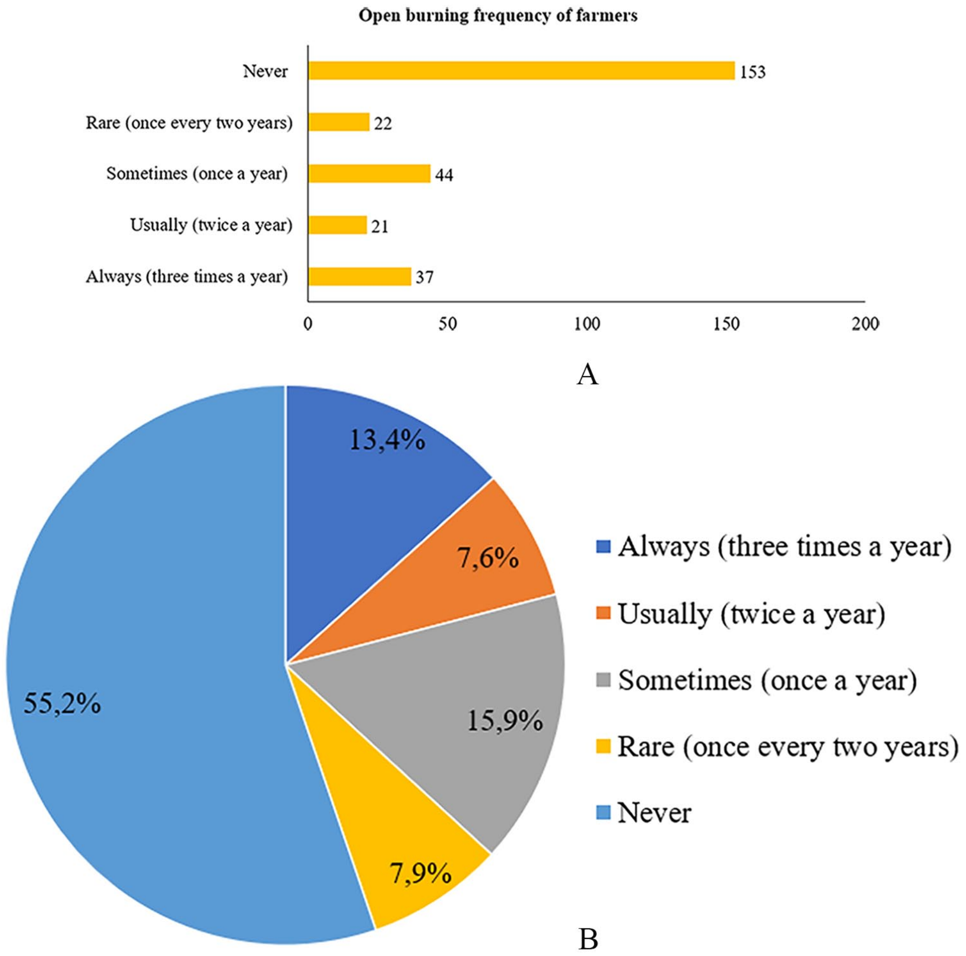


Figure 5. Frequency of straw burning by surveyed farmers.
(A) Frequency of open burning of farmers.
(B) The high percentage of farmers who participated in straw burning at least once.

Figure 7A presents the results of the assessment of farmers' and students' awareness of straw burning. Farmers agree that straw burning negatively affects the environment, leading to ecological imbalance, air pollution, and soil structure degradation, leading to soil degradation. However, they also see benefits in burning straw, such as creating fertilizer ash for crops and eliminating harmful pests. In contrast, students do not agree with burning straw, believing that this action destroys beneficial insects, disrupts ecological balance, causes air pollution, and regards straw as waste that needs to be burned. Students also believe that straw burning is ineffective in pest control. In general, both farmers and students agree that burning causes environmental pollution, but there is a clear difference in their perceptions of its impact on insects and the benefits of burning.

Figure 7B presents the results of the assessment of social pressure in straw burning. The results show that straw is often well managed and traders purchase it directly from the fields at prices ranging from 1 800 000 VND to 2 000 000 VND per hectare. Additionally, households with livestock use straw as feed and to grow straw mushrooms. Therefore, there is no significant social pressure to burn fields.

Figure 7C presents the results of the assessment of farmers' and students' attitudes and opinions about straw burning. Farmers believe that straw burning is unnecessary for modern agriculture, especially when technology and machinery have reduced the obstruction caused by straw. Straw burning generates smoke and dust, affecting the health of residents and causing unpleasant odors. Although both farmers and students recognize that burning creates fertilizer ash for crops, they agree that burning causes air pollution and is not encouraged.

Figure 7D presents the impact of direct-straw burning behavior. The survey indicates that the straw burning behavior is not supported. People generally do not watch, encourage, or help to gather straw for burning. Localities have organized training sessions and workshops to educate people about the harms of burning straw, raising awareness of environmental protection and community health. The perspectives of farmers and students on straw burning behavior are generally similar, recognizing its harmful effects, and not supporting the practice.

In summary, the survey results show that although straw burning still occurs, awareness of its harmful effects has been raised through educational and propaganda activities. This

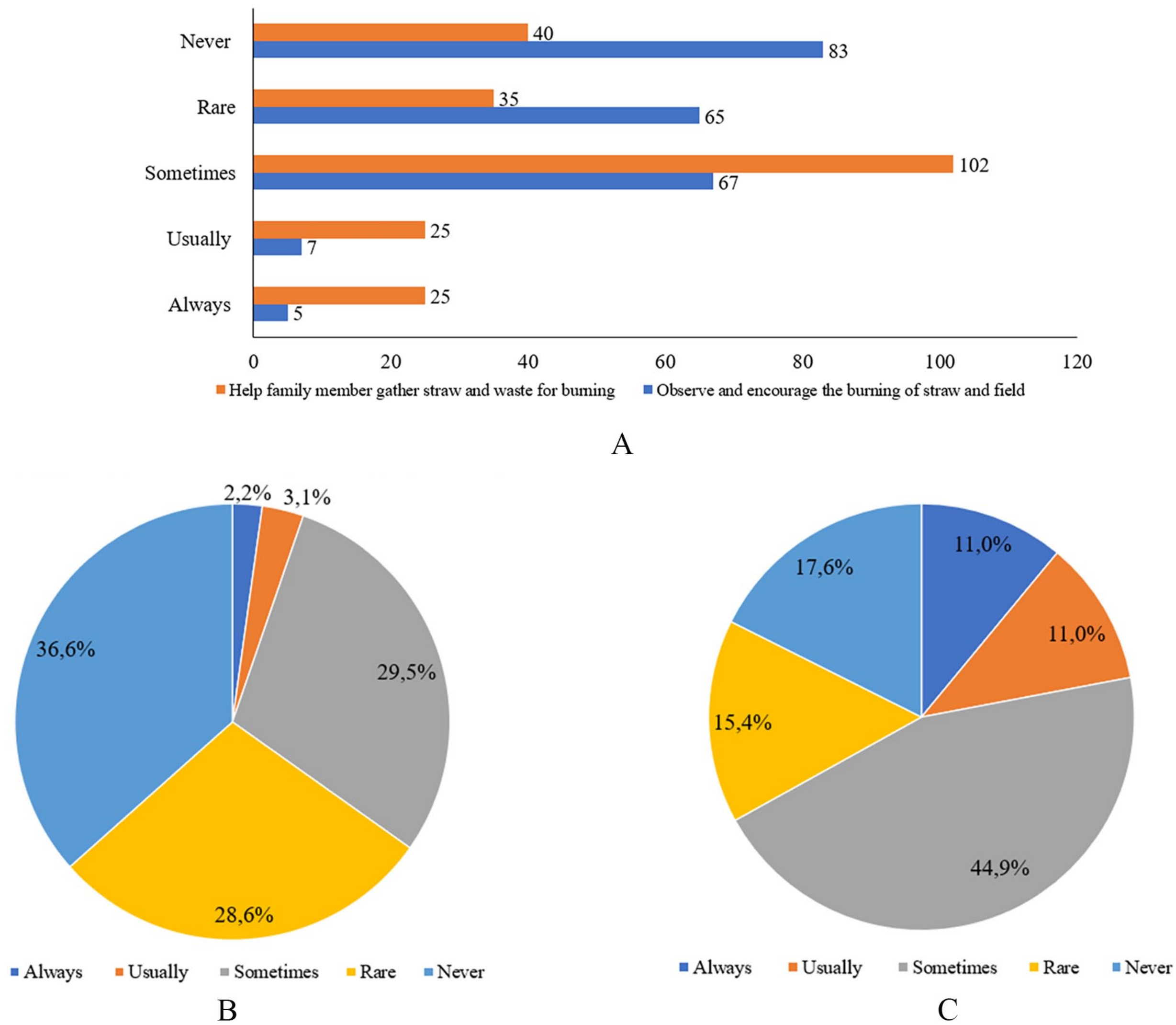


Figure 6. Students' actions in response to the current state of straw burning.
(A) Student response to the practice of burning straw and fields after harvest.
(B) Observe and encourage the burning of straw and the field.
(C) Help family member gather straw and waste for burning.

opens new directions to find and implement more effective alternative solutions to minimize negative impacts on the environment and community health.

Exploratory factor analysis (EFA)

EFA on factors influencing straw burning behavior among farmers. Pre-EFA scale reliability testing. To assess the reliability of the scales, we used 2 tools: the Cronbach's Alpha coefficient and factor analysis. Cronbach's Alpha is a statistical measure that evaluates the internal consistency of the items within a scale. The formula to calculate Cronbach's Alpha is: $\alpha = N * \rho[1+\rho*(N-1)]$, where ρ is the average inter-item correlation, and N is the number of elements. Conventionally, a scale is considered good if Cronbach's Alpha $\alpha > .8$. However, in cases where the concept being measured is new or the respondents are in a specific research context, a Cronbach Alpha of .6 or higher is deemed reliable and acceptable.[91]

Table 2 presents the results of the scale reliability testing before performing the EFA for farmers. The results show that the Cronbach's Alpha reliability coefficients for the scales related to "Awareness of Straw burning" (DNT), social pressure (DAL), and Attitudes and decisions (DQD) between farmers all exceed the .6 threshold, specifically .847, .916, and .924, respectively. This indicates that these scales have high reliability. Furthermore, all observed variables have a corrected item-total correlation greater than 0.3, indicating that each observed variable is closely related to the overall scale, ensuring that these variables effectively explain the factors they measure.

These results demonstrate that the scales have achieved the necessary reliability to proceed with EFA. The high Cronbach's Alpha coefficients indicate a strong internal consistency among the items within the scales, ensuring that the observed variables used in the research are appropriate and reliable. This reliability

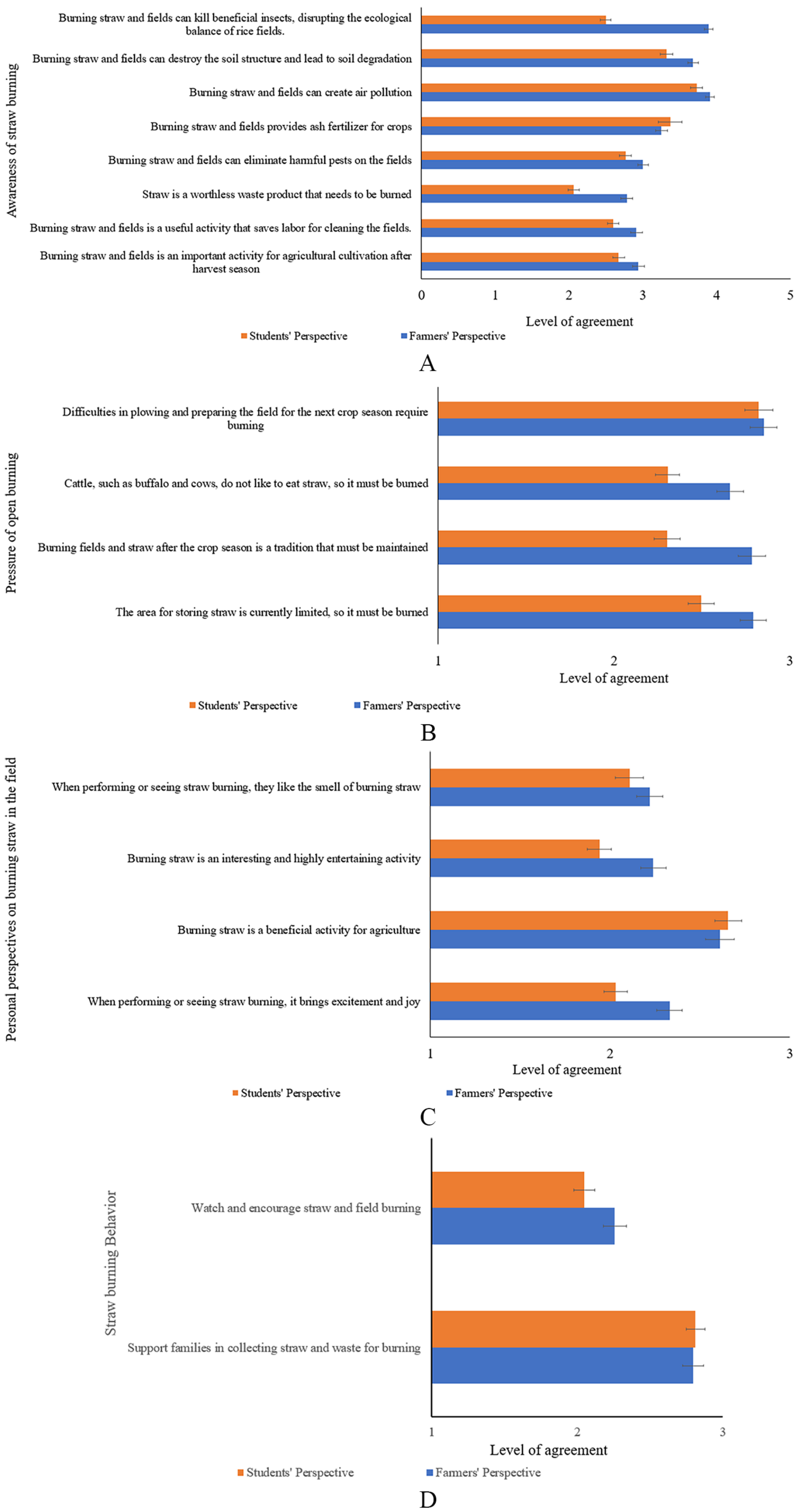


Figure 7. Factors affecting farmers' and students' perception of straw burning: Awareness (A), social pressure (B), attitudes and opinions (C), and behavior (D).
(A) Awareness of straw burning.
(B) Pressure of open burning.
(C) Personal perspectives on straw burning in the field.
(D) Straw burning behavior.

Table 2. Pre-EFA scale reliability testing results for farmers.

RELIABILITY STATISTICS		
FACTOR	CRONBACH'S ALPHA	N OF SURVEY QUESTIONS
Awareness (DNT)	0.847	8
Social Pressure (DAL)	0.916	4
Attitudes and Decisions (DQD)	0.924	4

Table 3. Bartlett's test of sphericity and KMO measure for farmers.

KMO AND BARTLETT'S TEST		
Kaiser-Meyer-Olkin measurement of sampling adequacy		0.842
Bartlett's Test of Sphericity	Approx. Chi-Square	1927.342
	df	36
	Sig.	0.000

allows us to proceed confidently with further analysis of the factors that influence farmers' awareness, social pressure, and decision-making attitudes regarding straw burning. Due to the high reliability of the scales, subsequent analyses will be based on solid foundations, leading to accurate and practical recommendations for managing and altering farmers' straw burning behavior.

Exploratory factor analysis (EFA). Table 3 presents the results of the Bartlett test and the KMO measure for the farmers who responded. The KMO measure is 0.842, which is greater than 0.5, indicating that the sample size is adequate and suitable for factor analysis. Additionally, Bartlett's test of sphericity has a Sig. value of 0.000, which is less than 0.05. This result shows that the correlations between the observed variables are sufficiently strong to proceed with factor analysis. These indices confirm that the use of the EFA is entirely appropriate for the data collected from farmers.

Table 4 presents the total variance explained by Bartlett's test for farmer respondents. During the analysis, 2 main factors were extracted based on the criterion of eigenvalues greater than 1. These 2 factors optimally summarize the information from the observed variables, with a total variance explained of 77.112%, which far exceeds the 50% threshold. This indicates that these 2 factors explain 77.112% of the variability in the data, demonstrating their strong ability to synthesize and condense information.

Table 5 presents the rotated component matrix for the observed variables after performing EFA. The observed variables are divided into 2 specific factors:

- Factor 1 includes the variables DNT1, DNT2, DNT3, DNT4, DNT5, and DAL4. These variables reflect aspects related to awareness and social pressure on straw burning.
- Factor 2 includes the variables DNT6, DNT7, and DNT8. These variables focus on the negative aspects and detrimental impacts of straw burning on the environment and ecology.

All observed variables have factor loadings greater than 0.5, indicating that these variables have a high explanatory power for the factors to which they belong. No variables were excluded, which shows that all observed variables are valuable in explaining the main factors of the study.

In summary, the results of the reliability test indicate that the scales are highly reliable and that the observed variables effectively explain the extracted factors. This not only confirms that the methods and sample of the study are appropriate but also provides a solid foundation for subsequent analyzes. Through this, the study can gain a deeper understanding of the factors that influence farmers' awareness, social pressure, and attitudes toward straw burning. Consequently, practical recommendations and solutions can be proposed to mitigate the negative impacts of this behavior on the environment and public health.

Pearson correlation analysis. The results of the Pearson's correlation analysis presented in Table 6 reveal a significant relationship between the independent variables and the dependent variable, Straw Burning Behavior (HVDD). Specifically, the variables DNT1, DNT2, DNT3, DNT4, DNT5, and DAL4 all have statistically significant Pearson's correlation coefficients (Sig. $< .05$) with HVDD, indicating a strong correlation with straw burning behavior. The correlation coefficients of these variables with HVDD are as follows. DNT1 (0.521), DNT2 (0.521), DNT3 (0.539), DNT4 (0.565), DNT5 (0.479), and DAL4 (0.554). This demonstrates that the awareness and attitudes toward straw burning, as the well as social pressure from the community, strongly influence their straw burning behavior. On the contrary, the variables DNT6, DNT7, and DNT8 have Sig. values > 0.05, indicating that they are not statistically significant in explaining HVDD, and thus will be excluded from the research model.

The variables DNT1 to DNT5 reflect farmers' awareness and attitudes toward straw burning, showing that straw when farmers believe that burning is necessary for cleaning the fields and eliminating pests, they tend to engage in this behavior more frequently. The variable DAL4, related to social pressure, also has a high correlation with HVDD, indicating that the pressure of the community or other social factors can encourage farmers to engage in straw burning. From these results, several measures can be proposed:

- Enhancing Education and Communication: Increase efforts to educate and communicate with farmers about

Table 4. Total variance explained by Bartlett's test for farmers.

TOTAL VARIANCE EXPLAINED									
COMPONENT	INITIAL EIGENVALUES			EXTRACTION SUMS OF SQUARED LOADINGS			ROTATION SUMS OF SQUARED LOADINGS		
	TOTAL	% OF VARIANCE	CUMULATIVE %	TOTAL	% OF VARIANCE	CUMULATIVE %	TOTAL	% OF VARIANCE	CUMULATIVE %
1	4.615	51.283	51.283	4.615	51.283	51.283	4.514	50.154	50.154
2	2.325	25.829	77.112	2.325	25.829	77.112	2.426	26.958	77.112
3	0.469	5.212	82.324						
4	0.437	4.853	87.177						
5	0.354	3.933	91.109						
6	0.283	3.147	94.256						
7	0.227	2.524	96.780						
8	0.183	2.031	98.810						
9	0.107	1.190	100.000						

Extraction Method: Principal Component Analysis.

Table 5. Rotated component matrix for Bartlett's test for farmers.

ROTATED COMPONENT MATRIXA		
	COMPONENT	
	1	2
Burning straw in the field is a useful activity that saves labor for field sanitation.	0.914	
The burning of straw in the field is an important activity for post-harvest agricultural practices.	0.881	
Burning straw in the field is an activity that can eliminate pest sources in the fields.	0.880	
Burning straw in the field is an activity that can produce ash as a fertilizer for crops.	0.847	
Straw is a waste product that needs to be burnt.	0.840	
The difficulty in tilling the field surface requires the burning of straw for subsequent cultivation.	0.817	
Burning straw in the field is an activity that can degrade and erode the soil.		0.918
The burning of straw in the field is an activity that can destroy beneficial insects, disrupting the ecological balance of the rice field.		0.897
Burning straw in the field is an activity that can cause air pollution.		0.862

the negative impacts of straw burning and promote sustainable alternatives.

- Reducing Social Pressure: Decrease the social pressure on farmers to burn straw by encouraging and supporting environmentally friendly straw management practices.
- Government and Organizational Support: Governments and related organizations should implement policies to support farmers transitioning to sustainable farming practices. This includes financial support and the provision of new equipment and technologies.

In summary, Pearson correlation analysis has identified key factors that influence farmers' straw burning behavior, providing a foundation for recommendation.

Multivariate regression analysis with independent and dependent factors on sludge burning behavior. To evaluate the model fit accurately, we need to test the hypothesis. To assess the fit of the regression model, we hypothesize H_0: $R^2 = 0$. The F-test is used to test this hypothesis. The test results are as follows:

Table 6. Pearson correlation coefficients for factors that affect farmers' straw burning behavior.

CORRELATIONS											
		HVDD	DNT1	DNT2	DNT3	DNT4	DNT5	DNT6	DNT7	DNT8	DAL4
HVDD	Pearson Correlation	1	0.521**	0.521**	0.539**	0.565**	0.479**	0.063	0.014	0.035	0.554**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000	0.279	0.804	0.543	0.000
	N	308	296	293	298	295	293	296	297	297	298
DNT1	Pearson Correlation	0.521**	1	0.869**	0.615**	0.692**	0.660**	0.188**	−0.040	0.056	0.639**
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000	0.001	0.484	0.328	0.000
	N	296	319	305	310	308	307	308	311	309	306
DNT2	Pearson Correlation	0.521**	0.869**	1	0.703**	0.712**	0.715**	0.197**	0.000	0.101	0.712**
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000	0.001	0.998	0.076	0.000
	N	293	305	309	303	306	301	304	307	307	302
DNT3	Pearson Correlation	0.539**	0.615**	0.703**	1	0.743**	0.654**	0.169**	0.070	0.156**	0.570**
	Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.000	0.003	0.218	0.006	0.000
	N	298	310	303	315	305	306	307	310	307	305
DNT4	Pearson Correlation	0.565**	0.692**	0.712**	0.743**	1	0.762**	0.211**	0.042	0.172**	0.678**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.000	0.458	0.003	0.000
	N	295	308	306	305	311	303	308	308	307	304
DNT5	Pearson Correlation	0.479**	0.660**	0.715**	0.654**	0.762**	1	0.260**	0.019	0.119*	0.617**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000		0.000	0.736	0.038	0.000
	N	293	307	301	306	303	310	303	307	304	302
DNT6	Pearson Correlation	0.063	0.188**	0.197**	0.169**	0.211**	0.260**	1	0.649**	0.640**	0.127*
	Sig. (2-tailed)	0.279	0.001	0.001	0.003	0.000	0.000		0.000	0.000	0.027
	N	296	308	304	307	308	303	313	308	308	305
DNT7	Pearson Correlation	0.014	−0.040	0.000	0.070	0.042	0.019	0.649**	1	0.762**	−0.029
	Sig. (2-tailed)	0.804	0.484	0.998	0.218	0.458	0.736	0.000		0.000	0.613
	N	297	311	307	310	308	307	308	314	310	307
DNT8	Pearson Correlation	0.035	0.056	0.101	0.156**	0.172**	0.119*	0.640**	0.762**	1	0.117*
	Sig. (2-tailed)	0.543	0.328	0.076	0.006	0.003	0.038	0.000	0.000		0.041
	N	297	309	307	307	307	304	308	310	313	304
DAL4	Pearson Correlation	0.554**	0.639**	0.712**	0.570**	0.678**	0.617**	0.127*	−0.029	0.117*	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.027	0.613	0.041	
	N	298	306	302	305	304	302	305	307	304	314

**Correlation is significant at the .01 level (2-tailed).
*Correlation is significant at the .05 level (2-tailed).

- Sig. < 0.05: Rejects H_0, meaning $R^2 \neq 0$ is statistically significant, indicating that the regression model is suitable.
- Sig. > 0.05: Accepts H_0, meaning $R^2 = 0$ is statistically significant, indicating that the regression model is not suitable.

In SPSS, the F-test data is obtained from the ANOVA analysis Table 7.

Table 7 presents the ANOVA results to evaluate the fit of the regression model for farmers. The ANOVA table provides the F-test results to assess the fit of the hypothesis of the

Table 7. ANOVA results to evaluate the fit of the regression model for farmers.

MODEL SUMMARY[b]					
MODEL	R	R SQUARE	ADJUSTED R SQUARE	STD. ERROR OF THE ESTIMATE	DURBIN-WATSON
1	.639[a]	.408	.395	1.92922	1.559

ANOVAA						
MODEL		SUM OF SQUARES	DF	MEAN SQUARE	F	SIG.
1	Regression	689.360	6	114.893	30.870	0.000[b]
	Residual	1001.191	269	3.722		
	Total	1690.551	275			

regression model. The Sig. value of the F-test is $0.000 < 0.05$, indicating that the regression model is appropriate.

When additional independent variables are included in the regression analysis, R^2 tends to increase. This can sometimes inflate the model's fit if weak or non-explanatory independent variables are included. In SPSS, in addition to the R^2 index, we also have the adjusted R^2 index. R^2 is a statistical measure that indicates the proportion of variance in the dependent variable that is explained by the independent variables in the regression model. Ranges from 0 to 1, with higher values indicating a better fit of the model. However, R^2 can be overly optimistic when multiple predictors are involved, as it tends to increase with the addition of more variables, regardless of their relevance. To address this, Adjusted R^2 adjusts for the number of predictors in the model, providing a more accurate measure of model performance. Unlike Adjusted R^2 can decrease if adding more variables does not improve the model's explanatory power. This makes Adjusted R^2 a more reliable indicator when comparing models with different numbers of independent variables.

The adjusted R^2 index does not necessarily increase with more independent variables in the regression, making it a more accurate reflection of the model fit compared to R^2. Both R^2 and adjusted R^2 range from 0 to 1. If R^2 approaches 1, the independent variables explain more of the variance in the dependent variable. Conversely, if R^2 approaches 0, the independent variables explain less of the variance in the dependent variable. An adjusted R^2 value of 0.395 indicates that the independent variables in the regression analysis explain 39.5% of the variance in the dependent variable, while the remaining 60.5% due to external factors and random errors.

We evaluate the regression coefficient of the significance of each independent variable in the model using the t-test (student) with hypothesis H_0: The regression coefficient of the independent variable X_i is 0. For each independent variable in the regression model, we tested the corresponding hypothesis H_0. The test results are as follows:

- Sig. < 0.05: Rejects H_0, meaning that the regression coefficient of the variable X_i is significantly different from 0, indicating that X_i affects the dependent variable.
- Sig. > 0.05: Accepts H_0, which means that the regression coefficient of variable X_i is not significantly different from 0, indicating that X_i does not affect the dependent variable.

If the regression coefficient (B or Beta) is negative, the independent variable negatively impacts the dependent variable. On the contrary, if B or Beta is positive, the independent variable positively impacts the dependent variable.

The results of the regression analysis in Table 8 show the relationship between the independent variables and the straw burning behavior. Specifically, the regression coefficient for the variable "Burning straw is essential for post-harvest agricultural practices" ($B = 0.336$, Sig. $= 0.059$) and "Straw is a worthless byproduct that needs to be burned" ($B = 0.285$, Sig. $= 0.051$) are close to statistical significance, suggesting that perception of the importance of straw burning and viewing straw as a waste product can influence this behavior. However, the variables "Burning straw saves labor for field cleaning" ($B = -0.098$, Sig. $= 0.632$) and "Burning straw creates fertilizer for crops" ($B = -0.085$, Sig. $= 0.570$) are not statistically significant, indicating that these factors do not affect straw burning behavior.

In particular, the variable "Difficulty in tilling the field surface, requiring burning' has the highest regression coefficient ($B = 0.555$, Sig. $= 0.000$), showing that the perception of difficulty in tilling and the need to burn straw to clean the field strongly influence straw burning behavior. This emphasizes that solutions to reduce tilling difficulties can help farmers reduce their dependence on straw burning. This study highlights the importance of cognitive and emotional factors in farmers' straw burning behavior, a new aspect compared to previous studies that focused mainly on technical and economic factors. These findings provide a scientific basis for designing comprehensive intervention programs, not only based on technical and economic factors but also considering farmers' cognitive and emotional factors, to protect the environment and public health.

Exploratory factor analysis (EFA) impact on straw burning behavior among students

Scale reliability testing before EFA. The results of the reliability test before conducting EFA for the surveyed students

Table 8. Regression coefficients based on the t-test for farmers.

COEFFICIENTS[a]								
MODEL		UNSTANDARDIZED COEFFICIENTS		STANDARDIZED COEFFICIENTS	T	SIG.	COLLINEARITY STATISTICS	
		B	STD. ERROR	BETA			TOLERANCE	VIF
1	(Constant)	1.210	0.320		3.784	0.000		
	Burning straw in the field is an important activity for post-harvest agricultural practices.	0.336	0.177	0.191	1.898	0.059	0.217	4.612
	Burning straw in the field is a useful activity that saves labor for field sanitation.	−0.098	0.205	−0.055	−0.479	0.632	0.169	5.921
	Straw is a worthless waste product that needs to be burned.	0.285	0.145	0.155	1.957	0.051	0.351	2.853
	Burning straw in the field is an activity that can eliminate pest sources in the fields.	0.340	0.174	0.179	1.948	0.052	0.261	3.833
	Burning straw in the field is an activity that can produce ash as fertilizer for crops.	−0.085	0.149	−0.045	−0.569	0.570	0.357	2.803
	Difficulty in tilling the field surface necessitates burning straw for subsequent cultivation.	0.555	0.134	0.299	4.135	0.000	0.420	2.379

[a]Dependent Variable: HVDD.

Table 9. Scale the reliability testing results before EFA for students.

FACTOR	RELIABILITY STATISTICS	
	CRONBACH'S ALPHA	N OF ITEMS
Awareness (DNT)	0.661	8
Social Pressure (DAL)	0.705	4
Attitudes and Decisions (DQD)	0.770	4

are presented in Table 9. The Cronbach's alpha coefficients indicate that all scales exceed the threshold of .6, confirming the high reliability of these scales. Specifically, the scale for the factor "Perception of Straw Burning" (DNT) has a Cronbach Alpha of .661, the scale for "Social Pressure to Burn Straw" (DAL) has an Alpha of .705, and the scale for "Attitude and Decision about Straw Burning" (DQD) has an Alpha of .770. All observed variables on these scales have a corrected item-total correlation greater than 0.3, demonstrating that these variables have good explanatory power for their respective factors. Thus, the scales have achieved the necessary reliability, allowing the conduction of the EFA.

This result indicates that the scales are reliable and have good explanatory power for the factors of perception, social pressure, and attitude of students toward straw burning, providing a solid foundation for the subsequent analysis steps in the study.

Exploratory factor analysis (EFA). After 3 rounds of EFA and elimination of unsuitable variables, the influencing factors were identified as shown in Table 10.

Table 10. Bartlett's test of sphericity and KMO measure for students.

KMO AND BARTLETT'S TEST		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.723
Bartlett's Test of Sphericity	Approx. Chi-Square	792.352
	df	55
	Sig.	0.000

The results of the scale reliability test before conducting the EFA for the student respondents are presented in Table 10. The KMO measure reached 0.723, greater than 0.5, indicating that the sample size is large and suitable for factor analysis. Additionally, the Bartlett test of Sphericity yielded a Sig. value of 0.000, which is less than 0.05, demonstrating that the observed variables are significantly correlated, meeting the conditions necessary for EFA. Thus, the test results indicate that the data collected from students meet the criteria for conducting exploratory factor analysis. The high KMO measure and the low Sig. The value of the Bartlett's test confirms the suitability of the model, laying a solid foundation for further analysis to explore factors affecting students' perceptions, social pressures, and attitudes toward burning straw in the fields.

Table 11 presents the total variance explained by Bartlett's test for the student respondents, illustrating the process of extracting factors from the survey data. The analysis results indicate that 3 main factors were extracted, each with an eigenvalue greater than 1, explaining a significant portion of the data variance. Specifically, the initial eigenvalue for the first factor was 3.073, accounting for 27.939% of the total

Table 11. Total variance explained by the Bartlett test for students.

TOTAL VARIANCE EXPLAINED									
COMPONENT	INITIAL EIGEN VALUES			EXTRACTION SUMS OF SQUARED LOADINGS			ROTATION SUMS OF SQUARED LOADINGS		
	TOTAL	% OF VARIANCE	CUMULATIVE %	TOTAL	% OF VARIANCE	CUMULATIVE %	TOTAL	% OF VARIANCE	CUMULATIVE %
1	3.073	27.939	27.939	3.073	27.939	27.939	2.577	23.425	23.425
2	2.318	21.075	49.014	2.318	21.075	49.014	2.269	20.626	44.052
3	1.636	14.870	63.884	1.636	14.870	63.884	2.182	19.832	63.884
4	0.808	7.342	71.226						
5	0.755	6.867	78.093						
6	0.501	4.554	82.647						
7	0.485	4.409	87.056						
8	0.435	3.953	91.009						
9	0.406	3.690	94.699						
10	0.350	3.181	97.881						
11	0.233	2.119	100.000						

Extraction method: Principal component analysis.

variance, and after matrix rotation, the Eigenvalue decreased to 2.577, explaining 23.425% of the total variance. The second factor had an initial eigenvalue of 2.318, accounting for 21.075% of the total variance, and after rotation it was 2.269, explaining 20.626% of the total variance. The third factor had an initial eigenvalue of 1.636, accounting for 14.870% of the total variance, and after rotation, it increased to 2.182, explaining 19.832% of the total variance. The cumulative variance explained by these 3 factors after rotation reached 63.884%, indicating that these factors effectively summarize and represent the observed variables in the study. The remaining factors, from the fourth onward, had Eigenvalues less than 1, suggesting that they were not strong enough to be considered independent factors in this analysis. Specifically, the fourth factor had an Eigenvalue of 0.808, accounting for 7.342% of the total variance, and subsequent factors had decreasing Eigenvalues. The extraction method used in this analysis was Principal Component Analysis (PCA), which optimizes the explanation of the overall variance of the observed variables in the model. Matrix rotation improved the explanatory power of the factors, resulting in a better explanation of the variance after rotation. Thus, the total variance results from Bartlett's test indicate that the 3 main factors extracted from the student data are sufficiently robust to represent the observed variables, providing a solid foundation for further analysis. This result confirms that the EFA model effectively explains the factors that influence students' perceptions, social pressures, and attitudes toward burning straw in the fields.

Table 12 presents the rotated component matrix of the Bartlett test for the student respondents, showing that the observed variables from the high school student survey were divided into 3 main factors, with all observed variables having a factor loading greater than 0.5. This indicates that these variables have high reliability and explanatory power. The results of the rotated matrix demonstrate that the observed variables were divided into 3 main factors with high factor loads (>0.5), confirming the strong explanatory power of the variables. This helps us to better understand students' perceptions, emotions, and attitudes toward burning straw. From this, appropriate educational and communication solutions can be proposed to reduce straw burning behavior, protect the environment, and improve air quality. This also helps guide specific policies and interventions to increase awareness and change the behavior of the student community, thus positively impacting the farming community and society as a whole.

Pearson correlation analysis. The results of the Pearson's correlation analysis presented in Table 13 show the relationships between the independent variables (DNT1, DNT2, DNT4, DNT5, DNT6, DNT7, DNT8, DAL4, DQD1, DQD3, DQD4) and the dependent variable (Straw burning behavior - HVDD). Analysis indicates that variables DNT4 (0.212**), DNT2 (0.282**), DNT1 (0.240**), DAL4 (0.219**), DQD3 (0.397**), DQD1 (0.430 **) and DQD4 (0.367**) have statistically significant Pearson correlation coefficients (Sig. < .05) with HVDD, indicating strong relationships with straw burning behavior. The variable DNT6 shows a negative correlation

Table 12. Rotated component matrix of Bartlett's test for students.

ROTATED COMPONENT MATRIX[a]			
	COMPONENT		
	1	2	3
Burning straw in the field is an activity that can eliminate pest sources in the fields.	0.785		
Burning straw in the field is an activity that can produce ash as fertilizer for crops.	0.773		
Burning straw in the field is a useful activity that saves labor for field sanitation.	0.729		
Burning straw in the field is an important activity for post-harvest agricultural practices.	0.728		
Difficulty in tilling the field surface necessitates burning straw for subsequent cultivation.	0.472		
Burning straw in the field is an interesting and highly entertaining activity.		0.886	
Burning straw in the field brings excitement and joy when performed or observed.		0.843	
Burning straw in the field creates a pleasing smell of burning straw when performed or observed.		0.816	
Burning straw in the field can destroy beneficial insects, disrupting the ecological balance of rice fields.			0.872
Burning straw in the field can damage and degrade the arable soil layer.			0.812
Burning straw in the field can cause air pollution.			0.793

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
[a]Rotation converged in 5 iterations.

coefficient (−.142*), but it is still statistically significant (Sig. < .05). Meanwhile, the variables DNT5, DNT7, and DNT8 have Sig. values > 0.05, which indicates no statistical significance in explaining the dependent variable HVDD, and therefore will be excluded from the research model.

The variables DNT1, DNT2, and DNT4 reflect the perceptions of straw burning, including considering it important for agricultural practices and as a source of fertilizer. The variable DAL4 is related to social pressure, showing that community or other social pressures can influence straw burning behavior. The variables DQD1, DQD3 and DQD4 relate to students' attitudes and decisions of the students about straw burning, indicating that positive attitudes have a strong connection to this behavior. The variable DNT6, although negatively correlated, is statistically significant and reflects awareness of the negative impacts of straw burning on the environment and ecology.

Based on these results, several measures can be proposed. Enhancing education and communication to raise students' awareness of the harmful effects of straw burning and sustainable alternatives is crucial. Reduce the social pressure on students to burn straw by encouraging and supporting environmentally friendly straw management methods is necessary. The supportive policies of government and related organizations can help students and communities adopt sustainable farming practices, minimizing straw burning. In summary, the Pearson's correlation analysis has clearly identified important factors influencing straw burning behavior, providing recommendations and solutions to mitigate the negative impacts on the environment and public health.

The findings presented in Table 13 highlight key factors that influence straw burning behavior, particularly among farmers and students. These factors include the perceived need to burn straw burning for agricultural practices, the belief in its benefits for pest control and the soil fertilization, and social pressures that encourage the continuation of this practice. These insights can serve as the foundation for targeted awareness programs and policy development. By addressing misconceptions about the benefits of straw burning and emphasizing the environmental and health impacts, educational initiatives can be tailored to change attitudes and behaviors. In addition, policies should focus on providing viable and cost-effective alternatives to straw burning, ensuring that farmers have the necessary support to adopt sustainable practices. Engaging local government officials in these programs will be essential, as they play a crucial role in influencing community practices. The findings underscore the importance of a multifaceted approach, combining awareness-raising efforts with practical policy measures to promote sustainable straw management and reduce the negative impacts of open burning.

Multivariate regression analysis of independent factors on straw burning behavior. Table 14 presents the ANOVA results through the F test to evaluate the fit of the hypothesis of the regression model. The significance value (Sig.) of the F test is 0.000, which is less than 0.05, indicating that the regression

Table 13. Pearson correlation coefficients for factors that influence student straw burning behavior.

CORRELATIONS													
		HVDD	DNT4	DNT5	DNT2	DNT1	DAL4	DQD3	DQD1	DQD4	DNT8	DNT7	DNT6
HVDD	Pearson Correlation	1	0.212**	0.084	0.282**	0.240**	0.219**	0.397**	0.430**	0.367**	−0.027	−0.006	−0.142*
	Sig. (2-tailed)		0.001	0.213	0.000	0.000	0.001	0.000	0.000	0.000	0.692	0.926	0.034
	N	228	222	222	223	223	226	227	227	227	224	221	224
1	Pearson Correlation	0.212**	1	0.569**	0.454**	0.405**	0.320**	0.206**	0.164*	0.160*	0.077	−0.042	0.125
	Sig. (2-tailed)	0.001		0.000	0.000	0.000	0.000	0.002	0.013	0.016	0.248	0.536	0.059
	N	222	227	225	226	226	225	226	226	226	227	224	227
2	Pearson Correlation	0.084	0.569**	1	0.213**	0.240**	0.165*	0.013	0.055	0.000	0.036	0.007	0.142*
	Sig. (2-tailed)	0.213	0.000		0.001	0.000	0.013	0.847	0.413	0.997	0.588	0.913	0.032
	N	222	225	227	226	226	225	226	226	226	227	224	227
3	Pearson Correlation	0.282**	0.454**	0.213**	1	0.561**	0.240**	0.222**	0.251**	0.157*	−0.111	−0.067	−0.085
	Sig. (2-tailed)	0.000	0.000	0.001		0.000	0.000	0.001	0.000	0.018	0.094	0.319	0.200
	N	223	226	226	231	230	227	228	228	228	228	225	228
4	Pearson Correlation	0.240**	0.405**	0.240**	0.561**	1	0.233**	0.240**	0.250**	0.160*	−0.044	−0.035	−0.005
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.015	0.510	0.605	0.942
	N	223	226	226	230	231	228	229	229	229	228	225	228
5	Pearson Correlation	0.219**	0.320**	0.165*	0.240**	0.233**	1	0.130*	0.145*	0.147*	0.151*	0.124	0.146*
	Sig. (2-tailed)	0.001	0.000	0.013	0.000	0.000		0.048	0.027	0.025	0.023	0.064	0.028
	N	226	225	225	227	228	232	232	232	232	227	224	227
6	Pearson Correlation	0.397**	0.206**	0.013	0.222**	0.240**	0.130*	1	0.685**	0.621**	−0.151*	−0.001	−0.136*
	Sig. (2-tailed)	0.000	0.002	0.847	0.001	0.000	0.048		0.000	0.000	0.022	0.984	0.041
	N	227	226	226	228	229	232	233	233	233	228	225	228
7	Pearson Correlation	0.430**	0.164*	0.055	0.251**	0.250**	0.145*	0.685**	1	0.513**	−0.085	−0.002	−0.128
	Sig. (2-tailed)	0.000	0.013	0.413	0.000	0.000	0.027	0.000		0.000	0.199	0.975	0.053
	N	227	226	226	228	229	232	233	233	233	228	225	228
8	Pearson Correlation	0.367**	0.160*	0.000	0.157*	0.160*	0.147*	0.621**	0.513**	1	−0.042	−0.031	−0.105
	Sig. (2-tailed)	0.000	0.016	0.997	0.018	0.015	0.025	0.000	0.000		0.532	0.649	0.112
	N	227	226	226	228	229	232	233	233	233	228	225	228
9	Pearson Correlation	−0.027	0.077	0.036	−0.111	−0.044	0.151*	−0.151*	−0.085	−0.042	1	0.600**	0.590**
	Sig. (2-tailed)	0.692	0.248	0.588	0.094	0.510	0.023	0.022	0.199	0.532		0.000	0.000
	N	224	227	227	228	228	227	228	228	228	229	226	229
10	Pearson Correlation	−0.006	−0.042	0.007	−0.067	−0.035	0.124	−0.001	−0.002	−0.031	0.600**	1	0.456**
	Sig. (2-tailed)	0.926	0.536	0.913	0.319	0.605	0.064	0.984	0.975	0.649	0.000		0.000
	N	221	224	224	225	225	224	225	225	225	226	226	226
11	Pearson Correlation	−0.142*	0.125	0.142*	−0.085	−0.005	0.146*	−0.136*	−0.128	−0.105	0.590**	0.456**	1
	Sig. (2-tailed)	0.034	0.059	0.032	0.200	0.942	0.028	0.041	0.053	0.112	0.000	0.000	
	N	224	227	227	228	228	227	228	228	228	229	226	229

**Correlation is significant at the .01 level (2-tailed).
*Correlation is significant at the .05 level (2-tailed).
1) Burning straw in the field is an activity that can eliminate pest sources in the fields.
2) Burning straw in the field is an activity that can produce ash as fertilizer for crops.
3) Burning straw in the field is a useful activity that saves labor for field sanitation.
4) Burning straw in the field is an important activity for post-harvest agricultural practices.
5) Difficulty in tilling the field surface necessitates burning straw for subsequent cultivation.
6) Burning straw in the field is an interesting and highly entertaining activity.
7) Burning straw in the field brings excitement and joy when performed or observed.
8) Burning straw in the field creates a pleasing smell of burning straw when performed or observed.
9) Burning straw in the field can destroy beneficial insects, disrupting the ecological balance of rice fields.
10) Burning straw in the field can damage and degrade the arable soil layer.
11) Burning straw in the field can cause air pollution.

Table 14. ANOVA results to assess model fit for regression analysis.

ANOVA[a]						
MODEL		SUM OF SQUARES	DF	MEAN SQUARE	F	SIG.
1	Regression	195.960	8	24.495	10.238	0.000[b]
	Residual	504.817	211	2.392		
	Total	700.777	219			

MODEL SUMMARY[b]					
MODEL	R	R SQUARE	ADJUSTED R SQUARE	STD. ERROR OF THE ESTIMATE	DURBIN-WATSON
1	.529[a]	.280	.252	1.54677	2.004

model is appropriate. A commonly used measure of the fit of a linear regression model is the R-squared (R^2) coefficient. If most data points are close to the regression line, the R^2 value will be high; conversely, if the data points are scattered far from the regression line, the R^2 value will be low. The R^2 value is found in the Model Summary section.

As we add more independent variables to the regression analysis, the R^2 tends to increase. This can lead to an overestimation of the model's fit when weak or irrelevant independent variables are included. In SPSS, alongside the R^2, the Adjusted R^2 (R^2 adjusted) is also provided. Adjusted R^2does not necessarily increase with the addition of more independent variables, thus reflecting the model's fit more accurately than the R^2. Both R^2 and Adjusted R^2 range between 0 and 1. The closer the R^2 is to 1, the more the independent variables explain the variation in the dependent variable. On the contrary, the closer R^2 is to 0, the less the independent variables explain the variation in the dependent variable. The Adjusted R^2 value of 0.252 indicates that the independent variables in the regression analysis account for 25.2% of the variation in the dependent variable, with the remaining 74.8% attributed to variables outside the model and random error.

We evaluate whether the regression coefficient of each independent variable is significant in the model using the t-test (student) with the null hypothesis H_0: The regression coefficient of the independent variable X_i is zero. The regression model will have as many hypotheses H_0 to test as there are independent variables. In this study, X_i represents the independent variables used in the regression analysis. These variables include factors such as demographic characteristics, awareness of environmental impacts, perceived benefits of straw burning, and willingness to adopt alternative practices. Each X_i is evaluated to determine its significance in predicting the dependent variable, which in this context is the overall behavior or attitude toward straw burning. By testing the regression coefficients of each X_i, we assess how these factors individually impact the outcomes related to straw management practices. The test results are:

- Sig. $<$ 0.05: Rejects the null hypothesis H_0, indicating that the regression coefficient of variable Xi is significantly different from zero, meaning that variable X_i affects the dependent variable.
- Sig. $>$ 0.05: Accepts the null hypothesis H_0, indicating that the regression coefficient of the variable X_i is not significantly different from zero, meaning that the variable X_i does not impact the dependent variable.

If the regression coefficient (B or Beta) is negative, the independent variable negatively impacts the dependent variable. On the contrary, if B or Beta is positive, the independent variable positively impacts the dependent variable.

The results of the regression analysis in Table 15 show the relationship between the independent variables and the straw burning behavior (HVDD) of the students. Regression coefficients include unstandardized coefficients (B), standardized coefficients (Beta), t values and significance values (Sig.). The analysis indicates that certain factors significantly influence the behavior of straw burning of students. Specifically, the variable "The excitement and joy when burning straw and fields" (Variable 6) has a coefficient B = 0.419 and Sig. = 0.006, showing that the excitement and joy in burning straw significantly and positively impact this behavior. This highlights that psychological and emotional factors play a crucial role in explaining straw-burning behavior, not just economic or technical factors. Conversely, other variables like "Burning straw and fields is important for postharvest agricultural practices" and "Burning straw and fields is a useful activity to save labor in cleaning fields" are not statistically significant in explaining straw burning behavior, with Sig. values $>$ 0.05.

A new point in this study is to emphasize the importance of psychological and emotional factors in explaining straw burning behavior. The results show that the excitement and joy of burning straw can be a strong motivator for this behavior. This opens a new approach to designing intervention and education programs to change straw burning behavior by introducing alternative activities that provide similar enjoyment but are less

Table 15. Regression coefficients based on the t-test for students.

COEFFICIENTS[a]							
MODEL	UNSTANDARDIZED COEFFICIENTS		STANDARDIZED COEFFICIENTS	T	SIG.	COLLINEARITY STATISTICS	
	B	STD. ERROR	BETA			TOLERANCE	VIF
(Constant)	2.553	0.501		5.100	0.000		
1	0.040	0.109	0.027	0.368	0.713	0.647	1.545
2	0.166	0.113	0.110	1.468	0.144	0.605	1.652
3	0.063	0.105	0.042	0.600	0.549	0.697	1.434
4	−0.148	0.089	−0.101	−1.655	0.099	0.918	1.090
5	0.187	0.096	0.124	1.947	0.053	0.840	1.191
6	0.419	0.150	0.236	2.803	0.006	0.482	2.073
7	0.200	0.168	0.111	1.187	0.236	0.394	2.540
8	0.163	0.116	0.109	1.410	0.160	0.571	1.752

[a]Dependent Variable: HVDD
1) Burning straw in the field is an important activity for post-harvest agricultural practices.
2) Burning straw in the field is a useful activity that saves labor for field sanitation.
3) Burning straw in the field is an activity that can eliminate pest sources in the fields.
4) Burning straw in the field is an activity that can cause air pollution.
5) Difficulty in tilling the field surface necessitates burning straw for subsequent cultivation.
6) Burning straw in the field brings excitement and joy when performed or observed.
7) Burning straw in the field is an interesting and highly entertaining activity.
8) Burning straw in the field creates a pleasing smell of burning straw when performed or observed.

harmful to the environment. Furthermore, recognizing the difficulties of tilling the surface and the need to burn straw to clean the fields has some impact, although not as strong as psychological factors. This study provides a scientific basis for developing policies and intervention programs that focus not only on economic and technical factors but also on psychological and social factors to reduce straw burning behavior, protect the environment and improve public health.

Policy implications and sustainable solutions

The findings of this study have profound policy implications, particularly in terms of the economic and practical challenges farmers face in adopting sustainable straw management practices. Given that economic constraints are a significant barrier, policy interventions should focus on creating an enabling environment where farmers are supported both financially and technically. One potential strategy is the implementation of subsidy programs that reduce the costs of sustainable practices such as composting, mulching, or bioenergy production. For example, governments could provide subsidies to purchase composting equipment or bioenergy machinery, making these alternatives more accessible and financially viable for farmers. In addition, financial incentives such as tax breaks or direct payments could be offered to farmers who adopt environmentally friendly practices, thereby reducing the economic burden and promoting widespread adoption.

Another critical aspect revealed by the study is the varying levels of awareness and readiness among local government officials. As key players in the implementation of policies, their understanding and support for sustainable practices are vital. The study suggests the need for targeted training programs tailored to local government officials, focusing on sustainable agriculture, environmental policies, and community engagement strategies. These programs should aim to enhance officials' capacity to advocate for sustainable practices effectively and to design and implement policies that address the unique needs of their communities. In addition, officials could be provided with guidelines and tools to monitor and evaluating the impact of straw management practices, ensuring that policies are both effective and adaptable over time.

Integrating community engagement strategies with policy initiatives is also essential to foster a collaborative approach to sustainable straw management. Policymakers should involve farmers, students, and local stakeholders in the policy making process to ensure that the proposed solutions are culturally appropriate and practically feasible. Community-based platforms such as farmer cooperatives, local environmental committees, and school programs can be used to disseminate information, provide training, and encourage collective action. By engaging communities in dialog and decision-making, policies can be tailored to local contexts, ensuring a higher likelihood of success and sustainability.

Recommendations for sustainable straw management

Based on the study findings, a multi-faceted approach to sustainable straw management is recommended, addressing the economic, educational, and policy dimensions of the issue.

1. **Economic Support for Farmers:** To address the economic challenges facing farmers, policy frameworks should focus on providing direct financial support and creating market incentives for sustainable practices. This could include establishing subsidies to purchase equipment required for composting or bioenergy production. Furthermore, governments could facilitate access to low-interest microfinance and loans specifically aimed at farmers who are transitioning to sustainable straw management methods. Furthermore, developing market mechanisms such as carbon credits or "green certifications" for sustainably produced rice can create additional revenue streams for farmers, making sustainable practices more economically attractive.
2. **Environmental Education for Students:** As the younger generation has the potential to drive long-term change, integrating environmental education into school curricula is crucial. Educational programs should emphasize the environmental and health impacts of straw burning, the benefits of sustainable agricultural practices, and ways students can participate in and advocate for environmental initiatives. Schools can collaborate with local agricultural and environmental agencies to organize hands-on learning experiences, such as field visits to model farms that practice sustainable straw management. By fostering environmental awareness and responsibility from an early age, these programs can contribute to shaping future generations' attitudes toward sustainable agriculture.
3. **Capacity-Building for Local Government Officials:** Enhancing the capacity of local government officials is key to the successful implementation of sustainable policies. Training programs should be designed to equip officials with the knowledge and skills needed to promote and enforce sustainable straw management practices. These programs could include modules on sustainable agriculture, environmental policy design, stakeholder engagement, and monitoring and evaluation techniques. In addition, establishing a network for local officials to share best practices and experiences can facilitate knowledge exchange and collaboration between different regions.
4. **Community-Based Programs:** Implementing community-based programs that involve all stakeholders can help bridge the gap between awareness and practice. One practical example is the promotion of community composting initiatives. These initiatives can provide a direct, low-cost alternative to straw burning, allowing farmers to convert straw into valuable compost that enriches the soil and reduces the need for chemical fertilizers. Local government support, such as the provision of composting equipment and technical training, can ensure the success of these initiatives. Furthermore, the creation of community demonstration sites can demonstrate the benefits of sustainable practices, serving as educational hubs where farmers can learn about and observe the positive results of alternative straw management methods.
5. **Monitoring and Evaluation: To** ensure the effectiveness of these recommendations, it is essential to establish monitoring and evaluation mechanisms. Regular assessments of the adoption rates of sustainable practices, changes in farmers' behaviors, and the environmental impact can provide valuable feedback for policymakers. This data-driven approach allows for continuous refinement of policies and programs, ensuring they remain responsive to the evolving needs of farmers and communities.

By implementing these comprehensive strategies, this study advocates for a collaborative approach to sustainable straw management that not only addresses immediate economic and environmental challenges but also fosters long-term behavioral change and sustainable agricultural development.

Conclusions

An evaluation involving over 686 participants from 3 main groups - farmers, students, and local officials - in 3 provinces of southeast Vietnam provided deep insights into perceptions and behaviors related to straw burning. In the modern context, with the availability of mechanized services and sustainable straw management methods, participants recognized that straw burning has detrimental effects on the environment and health. Farmers expressed a willingness to stop burning straw if alternative collection and processing methods that are less environmentally harmful were available, although they are reluctant to change their traditional farming practices significantly. Both students and officials understood the harms of straw burning and agreed on the need to educate and guide farmers toward the use of alternative methods.

The findings of this study are consistent with existing literature on the challenges of promoting sustainable agricultural practices. Which found that economic constraints and lack of awareness were key barriers to adopting sustainable farming methods, our research revealed that farmers in southeast Vietnam are willing to change practices, but face financial and informational obstacles. Additionally, our results align with many other studies in many different regions, which reported that community involvement and targeted educational programs are critical in shifting agricultural behaviors. However, our study contributes new insights by highlighting the specific cultural and socio-economic context of straw burning in Southeast Vietnam, demonstrating that while national policies have been proposed, local factors significantly influence their effectiveness. This research extends current knowledge by suggesting that policies must be tailored to local contexts, incorporating economic incentives, community education, and capacity-building for local officials to create sustainable change. By situating our findings within the broader scientific discourse, we underline the complexity of the issue and the need for multifaceted approaches to address it.

This study holds significant value for policy makers in their efforts to reduce air pollution by shifting farmers from burning straw toward sustainable straw management practices. This is particularly important not only in Vietnam but also in other delta regions of Asia. A deep understanding of public perception also opens up new research avenues to develop effective straw processing products without requiring farmers to alter their traditional farming practices. This contributes to improving crop residue management worldwide, thereby protecting the environment and public health.

However, there are some limitations to this study. First, while the research utilized a stratified random sampling method to ensure diversity, it was geographically limited to 3 provinces. This may affect the generalizability of the findings to other regions with different agricultural practices and socioeconomic contexts. Second, the study primarily focused on assessing current awareness and attitudes without implementing direct interventions or training programs, which could have provided further insights into the effectiveness of the proposed solutions.

Future research should explore the impact of targeted interventions, such as educational programs and policy initiatives, on changing straw burning behaviors in a broader geographical context. Furthermore, studies could investigate the long-term effectiveness of sustainable straw management practices and the role of economic incentives in promoting their adoption. By addressing these areas, future research can contribute to the development of more effective strategies to mitigate the environmental and health impacts of straw burning.

Author's Note

This is to certify that, to the best knowledge of the authors, the content of this manuscript is original. The article has not been submitted elsewhere nor published anywhere.

The authors confirm that the intellectual content of this paper is the original product of our work and all the assistance or funds from other sources have been acknowledged.

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Originality Statement

'I hereby declare that this submission is my own work and, to my knowledge it contains no previously published or written by another person, or substantial proportions of material. Any contribution made to the research by others, with whom I have worked on the draft or elsewhere, is explicitly acknowledged in the draft.

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