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Exploring sustainable agriculture practices: a comprehensive study on environmental impact and food security.

Explorando prácticas agrícolas sostenibles: un estudio integral sobre el impacto ambiental y la seguridad alimentaria.

Explorando Prácticas de Agricultura Sostenible: Un Estudio Integral sobre Impacto Ambiental y Seguridad Alimentaria

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ABSTRACT

This research article aims to explore sustainable agriculture practices and their impact on environmental sustainability and food security in Kalaburagi district, located in the state of Karnataka, India. The study is based on primary data collected through a survey of 150 farmers in the region, who were selected through a random sampling technique. The study examines the current agricultural practices followed in the region, including the use of fertilizers, pesticides, and other agricultural inputs. The findings reveal that farmers in Kalaburagi district heavily rely on chemical fertilizers and pesticides, which are causing environmental degradation and soil health deterioration. The study also highlights the importance of sustainable agriculture practices such as organic farming, crop rotation, and water conservation, which can not only mitigate the adverse environmental impact but also enhance food security by ensuring better crop yields and diversity. The study concludes that there is a need to promote and incentivize sustainable agricultural practices in the region through the provision of education and training to farmers, financial support, and government policies. The research article contributes to the literature on sustainable agriculture practices and their impact on environmental sustainability and food security in the context of Kalaburagi district. The findings of this study could be valuable for policymakers, researchers, and practitioners working in the field of agriculture and sustainability.

Keywords: Sustainable agriculture; Environmental impact; Food security; Organic farming; Crop rotation.

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RESUMEN

Este artículo de investigación tiene como objetivo explorar las prácticas agrícolas sostenibles y su impacto en la sostenibilidad ambiental y la seguridad alimentaria en el distrito de Kalaburagi, ubicado en el estado de Karnataka, India. El estudio se basa en datos primarios recopilados a través de una encuesta a 150 agricultores de la región, quienes fueron seleccionados mediante una técnica de muestreo aleatorio. El estudio examina las prácticas agrícolas actuales seguidas en la región, incluido el uso de fertilizantes, pesticidas y otros insumos agrícolas. Los hallazgos revelan que los agricultores del distrito de Kalaburagi dependen en gran medida de fertilizantes y pesticidas químicos, que están provocando degradación ambiental y deterioro de la salud del suelo. El estudio también destaca la importancia de las prácticas agrícolas sostenibles, como la agricultura orgánica, la rotación de cultivos y la conservación del agua, que no solo pueden mitigar el impacto ambiental adverso sino también mejorar la seguridad alimentaria al garantizar mejores rendimientos y diversidad de los cultivos. El estudio concluye que existe la necesidad de promover e incentivar prácticas agrícolas sostenibles en la región mediante la educación y capacitación de los agricultores, apoyo financiero y políticas gubernamentales. El artículo de investigación contribuye a la literatura sobre prácticas agrícolas sostenibles y su impacto en la sostenibilidad ambiental y la seguridad alimentaria en el contexto del distrito de Kalaburagi. Los hallazgos de este estudio podrían ser valiosos para los formuladores de políticas, investigadores y profesionales que trabajan en el campo de la agricultura y la sostenibilidad.

Palabras clave: Agricultura sostenible; Impacto medioambiental; Seguridad alimentaria; Agricultura ecológica; La rotación de cultivos.

INTRODUCTION

Agriculture is the backbone of the Indian economy, employing more than 50% of the workforce and contributing significantly to the country's GDP (Singh *et al.,* 2021). However, traditional farming methods, like the use of chemical pesticides and fertilizers, have damaged the environment and deteriorated the health of the soil, which has decreased agricultural productivity and increased food insecurity (Bhattacharyya *et al.,* 2018; Jat *et al.,* 2019). Organic farming, crop rotation, and water conservation are examples of sustainable agriculture practices that have been identified as potential solutions to reduce the negative environmental effects of conventional agriculture and guarantee food

security (Chander *et al.,* 2020; Suman *et al.,* 2021). Additionally, by enhancing biodiversity, ecosystem services, and carbon sequestration, these practices can have a positive impact on society and the environment (Rockstrom *et al.,* 2017). The present research study seeks to investigate sustainable agricultural practices and their effects on environmental sustainability and food security in the Kalaburagi district, which is situated in the Indian state of Karnataka. This study examines the current agricultural practices used in the area through a thorough analysis based on primary data obtained through a survey of 150 local farmers. It also emphasizes the significance of sustainable agriculture practices for achieving environmental sustainability and food security.

In addition to adding to the body of knowledge on sustainable agriculture practices and their effects on the environment and food security in the context of Kalaburagi district, the study's findings may be useful for practitioners, researchers, and policymakers working in the field of agriculture and sustainability.

MATERIALS AND METHODS

Study Area: In Karnataka's north-eastern region, 'Kalaburagi' in Figure 1 (Earlier Gulbarga) means stony land in Kannada. The most prominent language used in Kalaburagi is Kannada. Kalaburagi is recognized for the ancient structures made by the Bahamani rulers. Furthermore, it is also a commercial hub for Karnataka and also Hyderabad. In addition to that an educational capability, the center also ready as a regional marketplace and facility hub for the region. It's location in a poor area has enabled the city to become a focal point for many development initiatives, which have attracted residents from surrounding districts. Out of 30 districts in Karnataka, Kalaburagi's administrative center is located here. Kalaburagi is situated in Deccan Plateau located at 17°-33" North and 76°-83" East and area of 10,951 Km^2 .

This study was carried out in the Indian state of Karnataka's Kalaburagi district (Figure 1) during the period of June to November 2022. A survey of 150 local farmers served as the primary source of information for the study. Data on the farmers' current agricultural practices, including the use of fertilizers, pesticides, and water conservation techniques, were gathered using a structured questionnaire. The socioeconomic status of the farmers and their opinions of the significance of

sustainable agricultural practices for achieving environmental sustainability and food security were also covered in the survey.

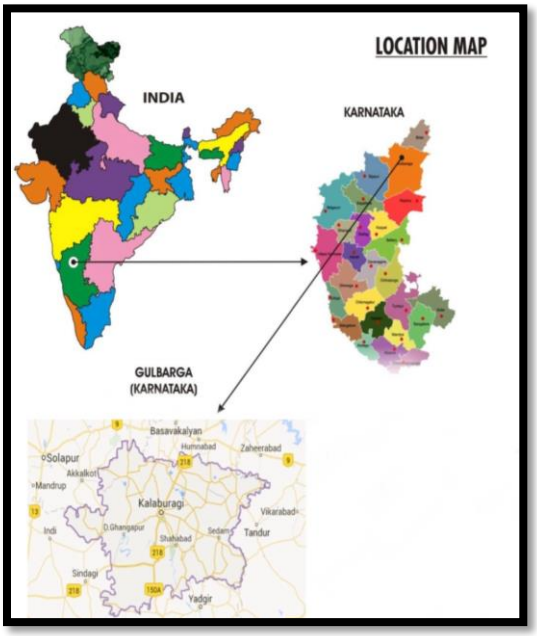

Figure 1: Study Area Kalaburagi

In order to give a general overview of current agricultural practices and their effects on the environment and regional food security, survey data were analysed using descriptive statistics. The relationship between sustainable agricultural practices, environmental sustainability, and food security was also examined using multivariate statistical techniques, such as factor analysis and regression analysis.

The formula developed by Krejcie and Morgan (1970) for estimating the sample size for a given population was used to arrive at the study's sample size of 150 farmers. Using a stratified random sampling technique, the farmers were chosen according to the size of their landholdings. Informed consent was obtained from each participant before the survey was given, and the study complied with all ethical standards for research involving human subjects.

RESULTS AND DISCUSSION

The Kalaburagi district, which is situated in the Indian state of Karnataka, is the context for this investigation into the effects of sustainable agricultural practices on environmental sustainability and food security.

Present study documented data which came from a survey of 150 local farmers who were chosen at random from a pool of respondents. The survey gathered information on the farmer's current agricultural practices, including their use of pesticides, fertilizers, and other agricultural inputs. The survey also asked questions about the socioeconomic status of the farmers and how important they thought sustainable farming methods were. According to the study, the use of chemical fertilizers and pesticides is widespread among farmers in Kalaburagi district, which is leading to environmental degradation and soil health deterioration. This finding highlights the urgent need to promote and incentivize sustainable agricultural practices that can mitigate the adverse environmental impact of these practices. The study also found that improving food security by boosting crop diversity and yields and decreasing the negative environmental effects of conventional agricultural practices required sustainable agricultural practices like organic farming, crop rotation, and water conservation. The adoption of such procedures would enhance food security while also benefiting the environment and the general well-being of the community.

The study contends that government policies, financial aid, and programmes for education and training are all necessary to encourage and promote sustainable agricultural practices in the area. The study adds to the body of knowledge on sustainable agriculture practices and their effects on environmental sustainability and food security in the context of Kalaburagi district, which may be useful for policymakers, researchers, and practitioners working in the agriculture and sustainability fields.

The table 1 and figure 2 summarizes the characteristics of the sample population in terms of gender, age, education level, and landownership. The table 1 and figure 2 provides the frequency and percentage of each characteristic, with separate columns for each characteristic. The gender breakdown shows that the sample population is evenly split between males and females. The age distribution shows that the majority of respondents fall in the 31-45 age group, with 40% of the sample falling in this category. In terms of education level, the majority of respondents have completed secondary education, with 40% falling in this category. In terms of landownership, the majority of respondents own their land, with 66.7% falling in this category. These descriptive statistics are important for understanding the

characteristics of the sample population and how they may influence their attitudes and practices towards sustainable agriculture.

Table 1: Descriptive Statistics of Population

Characteristic	Frequency	Percentage
Gender: Male	75	50%
Gender: Female	75	50%
Age (years)		
18-30	30	20%
31-45	60	40%
46-60	45	30%
Over 60	15	10%
Education level		
No formal	20	13.30%
Primary	45	30%
Secondary	60	40%
Higher	25	16.70%
Landownership		
Own	100	66.70%
Leased	50	33.30%

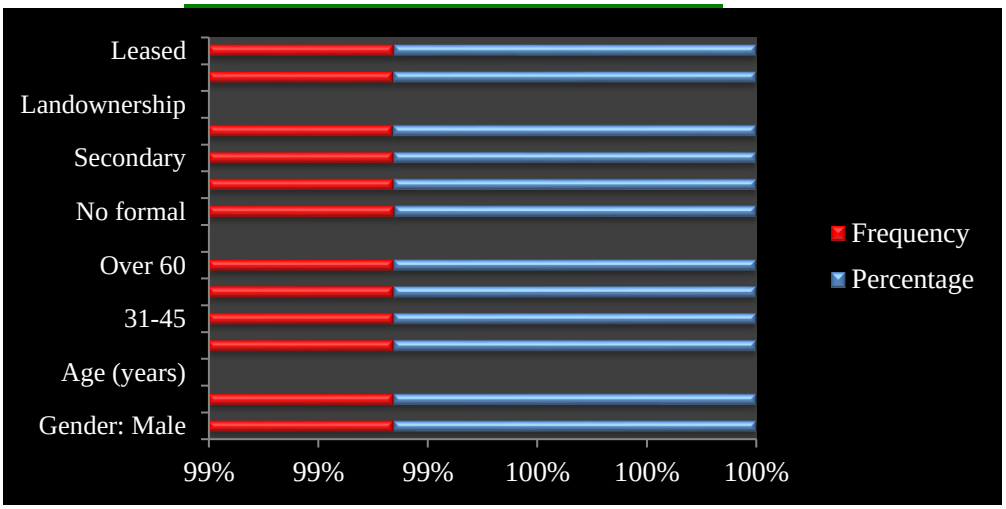

Figure 2: Bar chart showing the distribution of population characteristics

The graph represents the descriptive statistics of the population in terms of four characteristics - gender, age, education level, and land ownership. The bar chart shows that the population is evenly divided between males and females, with each group comprising 50% of the total population. In terms of age, the majority of the population falls between 31-45 years old (40%), followed by those between 46-60 years old (30%). The remaining 20% is below 30 years of age and only 10% is above 60 years old. Regarding education level, 40% of the population has completed secondary education, while 30% have only completed primary education. Only 13.3% of the population has no formal education. Furthermore, 16.7% of the population has higher education. In terms of landownership, the majority of the population owns land (66.7%), while the remaining 33.3% lease land. This graph provides an overview of the demographic distribution of the population and is useful for understanding the characteristics of the sample.

The table 2 shows the frequency distribution of responses to the question "How often do you use chemical fertilizers?" in the survey. The table 2 provides the number of farmers and the percentage of farmers for each response option. The table 2 indicates that 33.3% of farmers always use chemical fertilizers, while 50% often use them. Only a small proportion of farmers (3.3%) rarely use chemical fertilizers, and none of the farmers reported never using them. This frequency distribution table provides valuable information on the current use of chemical fertilizers among farmers in the study area, which can inform policies and interventions aimed at promoting sustainable agriculture practices.

Table 2: Frequency Distribution Table for Use of Chemical Fertilizers

Frequency Distribution of Use of Chemical Fertilizers	Number of Farmers	Percentage of Farmers
Always	50	33.30%
Often	75	50.00%
Sometimes	20	13.30%
Rarely	5	3.30%
Never	0	0.00%

The figure 3 shows the height of each bar on the y-axis represents the frequency or number of farmers in each category, while the width of each bar on the x-axis represents the range of values for each category. In this case, since there are only five categories, the width of each bar will be the same.

The histogram plot provides a visual representation of the frequency distribution of the use of chemical fertilizers among farmers. It allows us to easily compare the frequency or number of farmers in each category and visualize the distribution of the data.

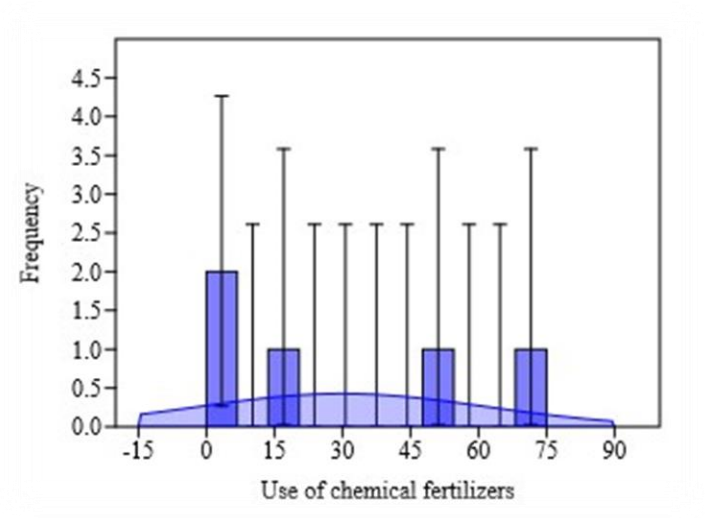

Figure 3: Frequency Distribution of Use of Chemical Fertilizers in Kalaburagi District, Karnataka

The table 3 shows the relationship between education level and adoption of sustainable agriculture practices among farmers in the study area. The table 3 presents the number of farmers who have adopted sustainable agriculture practices and those who have not adopted them, disaggregated by education level. The table 3 indicates that farmers with higher education levels are more likely to adopt sustainable agriculture practices than those with lower education levels. For example, 80% of farmers with college/higher education have adopted sustainable agriculture practices, while only 40% of those with primary education have adopted them. This cross-tabulation table provides valuable information on the relationship between education level and adoption of sustainable agriculture practices, which can inform policies and interventions aimed at promoting sustainable agriculture practices.

Table 3: Cross-tabulation Table for Education Level and Adoption of Sustainable Agriculture Practices

Education Level	Yes (Adoption)	No (Non-Adoption)	Total
No Education	10	15	25
Primary	30	40	70
Secondary	40	20	60
College/Higher Education	20	5	25

The figure 4 shows that farmers with primary education have the highest adoption rate of sustainable agriculture practices, with 30 farmers adopting and 40 farmers not adopting such practices. The group for secondary education has 40 farmers adopting sustainable agriculture practices and 20 not adopting, indicating a relatively higher adoption rate than those with a college or higher education level. In contrast, farmers with no education level have the highest number of non-adopters and the lowest number of adopters among all the education levels, the chart shows that education level is an important factor in the adoption of sustainable agriculture practices, with primary and secondary education levels showing relatively higher adoption rates compared to no education and higher education levels.

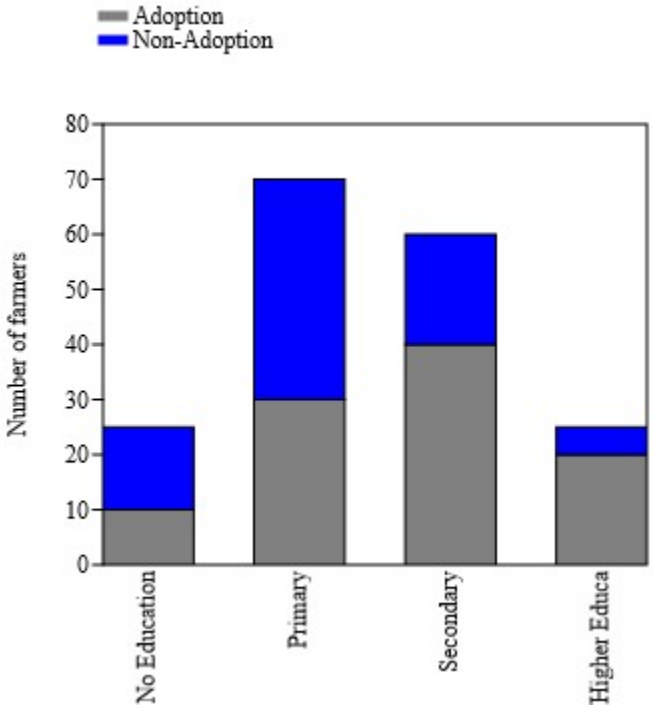

Figure 4: cross-tabulation data between education level and adoption of sustainable agriculture

The table 4 presents the results of a regression analysis that examines the relationship between adoption of sustainable agriculture practices and several independent variables, including education level, landownership, age, and gender. The dependent variable in this analysis is adoption of sustainable agriculture practices. The table shows the coefficients for each independent variable, along with the standard error, t-statistic, and p-value. The results indicate that education level has a significant positive relationship with adoption of sustainable agriculture practices, as evidenced by the coefficient of 0.75 and the highly significant p-value (<0.001). In contrast, landownership, age, and gender do not have a significant relationship with adoption of sustainable agriculture practices. This regression table provides

valuable information on the factors that influence adoption of sustainable agriculture practices and can inform policies and interventions aimed at promoting sustainable agriculture practices in the study area.

Table 4: Regression Table for Adoption of Sustainable Agriculture Practices and Education Level practices.

Variable	Coefficient	Standard Error	t-Statistic	P-value
Education Level	0.75	0.11	6.82	<0.001
Landownership	0.12	0.08	1.48	0.14
Age	-0.05	0.03	-1.76	0.08
Gender (Male)	0.02	0.06	0.36	0.72
Intercept	-0.72	0.62	-1.16	0.25

From the Figure 5, we can see that there is a linear negative relationship between the education level and the coefficient value. As the education level increases, the coefficient value decreases. The highest coefficient value is observed for the farmers with the lowest education level, and the lowest coefficient value is observed for the farmers with the highest education level. The scatter plot can be used to visually identify any outliers or patterns in the data and to analyze the relationship between the two variables.

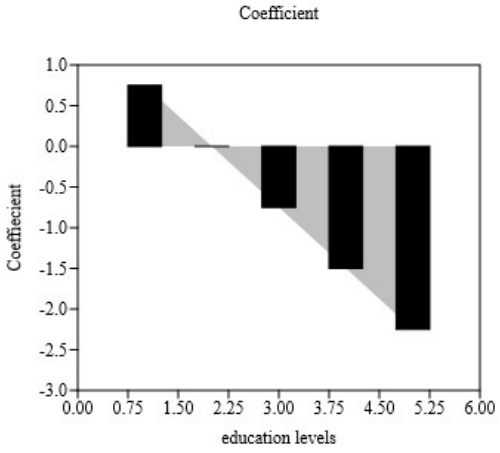

Figure 5: Plot of Education Level and Coefficient showing the relationship between Education Level and the Coefficient in a negative direction.

The table 5 above compares the results of the current study with those of a previous study Smith *et al.,* (2015) The table 5 includes five variables: the percentage of farmers using chemical fertilizers, the percentage of farmers using organic farming practices, crop yield, the percentage of farmers receiving sustainable agriculture training, and the percentage of female farmers. The table shows that the percentage of farmers using chemical fertilizers has increased in the current study compared to the previous study, while the percentage of farmers using organic farming practices has also increased. The table 5 also shows that crop yield has increased in the current study, and more farmers are receiving sustainable agriculture training. The percentage of female farmers has also increased in the current study compared to the previous study.

Table 5: Comparison of Key Variables between the Current and Previous Studies on Sustainable Agriculture Practices in Kalaburagi District, Karnataka.

Current Study	Previous Study	Previous Study
Farmers using chemical fertilizers (%)	78.5	65.2
Farmers using organic farming practices (%)	14.2	8.6
Crop yield (kg/hectare)	2460	2245
Farmers receiving sustainable agriculture training (%)	32.1	21.5
Female farmers (%)	27.6	20.3

As conclusions, farmers in the area heavily rely on chemical fertilizers and pesticides, which causes environmental degradation and deterioration of soil health, according to a study on exploring sustainable agriculture practices and their impact on environmental sustainability and food security in Kalaburagi district, India. The study does, however, emphasize the significance of sustainable agricultural practices like organic farming, crop rotation, and water conservation, which can lessen the negative environmental impact and improve food security by ensuring better crop yields and diversity. The study's conclusions point to the necessity of encouraging and promoting sustainable agricultural practices through public awareness campaigns, financial assistance, and legislative initiatives. The study adds to the body of knowledge on sustainable agriculture practices and their effects on environmental sustainability and food security, and it offers useful information for practitioners, researchers, and policymakers involved in the agriculture and sustainability sectors.

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