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Determinants of Food Security in Rural Households: An Analysis of Dietary Diversity, Land Ownership, and Socioeconomic Factors

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Abstract

Background: Food security is a critical issue in rural areas, influenced by various socioeconomic factors, dietary practices, and resource ownership. Understanding the determinants of food security can help in designing effective interventions to improve the well-being of rural households. **Purpose:** This study aims to identify and analyze the key determinants of food security among rural households, focusing on dietary diversity, land ownership, and other socioeconomic factors. **Methods:** The dataset used in this study includes variables such as gender, marital status, education, land ownership, food crop cultivation, meal frequency, age, food source, Food Security Index (FSI), and Household Dietary Diversity Score (HDDS). Multiple linear regression analysis was conducted to explore the relationships between these variables and the FSI. Additionally, a Random Forest Regressor model was employed to predict the FSI and to determine the importance of each feature. **Results:** The multiple linear regression analysis revealed that HDDS has a significant positive relationship with the FSI ($p<0.001$), indicating that higher dietary diversity is associated with higher food security levels. Other variables, such as education and food source, showed weaker correlations with food security. The Random Forest Regressor model achieved an R-squared value of 0.495, with feature importance analysis indicating that HDDS, food source, and age are the most influential factors in determining food security. The Mean Squared Error (MSE) of the model was 10.743. **Conclusion:** This research highlights the crucial role of dietary diversity and socioeconomic conditions in shaping food security outcomes in rural areas. The findings provide valuable insights for policymakers and stakeholders aiming to enhance food security and dietary quality in rural communities. Further studies are recommended to explore the complex interactions between these variables and to develop targeted interventions to improve food security.

Keywords: Food Security, Rural Households, Dietary Diversity, Socioeconomic Factors

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1. BACKGROUND

Food security remains a significant challenge in rural areas, where access to diverse and nutritious food is often limited by various constraints (Mekonnen et al., 2021). These constraints include economic instability, lack of education, inadequate land ownership, and limited access to markets and agricultural resources. In rural settings, the ability to secure a stable and nutritious food supply is not only a matter of immediate survival but also a critical factor influencing long-term health, productivity, and social stability (Bilali, 2019).

Socioeconomic factors, such as education, land ownership, and income levels, are crucial determinants of food security. Households with higher educational attainment often have better access to information and resources, enabling them to make informed decisions about food production and consumption. Land ownership is another significant factor, as it provides the means for households to cultivate their own food and reduce dependency on external food sources (Oyo & Kalema, 2016). Furthermore, income levels influence a household's ability to purchase diverse and nutritious foods, impacting overall dietary quality.

Dietary diversity, which measures the variety of foods consumed, serves as a key indicator of nutritional quality and food security. A diverse diet is typically associated with better health outcomes, as it ensures the intake of essential nutrients required for growth, development, and disease prevention. In many rural areas, however, dietary diversity is often compromised due to limited food availability and economic constraints, leading to poor nutritional outcomes and increased vulnerability to food insecurity (FAO, 2010).

Understanding the complex interactions between these socioeconomic factors and dietary diversity is essential for developing effective strategies to enhance food security in rural communities. This study aims to explore these interactions by analyzing a comprehensive dataset that includes variables such as gender, marital status, education, land ownership, food crop cultivation, meal frequency, age, food source, Food Security Index (FSI), and Household Dietary Diversity Score (HDDS) (Briones Alonso et al., 2018). By examining these variables, the research seeks to identify the key determinants of food security and provide insights that can inform policy and intervention programs aimed at mitigating food insecurity in rural settings.

The findings of this study are expected to contribute to a deeper understanding of the multifaceted nature of food security and highlight the importance of addressing both socioeconomic and dietary factors in efforts to improve the well-being of rural households (Baliwati et al., 2015). By identifying the critical factors that influence food security, policymakers and stakeholders can develop targeted interventions that promote sustainable food systems, enhance dietary diversity, and ultimately improve the quality of life for rural populations.

2. METHODS

This study employs a quantitative approach to analyze the determinants of food security among rural households. The dataset used in this research includes a variety of variables, such as gender, marital status, education, land ownership, food crop cultivation, meal frequency, age, food source, Food Security Index (FSI), and Household Dietary Diversity Score (HDDS)(Mahmudiono et al., 2017). These variables were collected from a sample of rural households, providing a comprehensive overview of the factors influencing food security in these communities.

The dataset was first cleaned and preprocessed to ensure accuracy and completeness. Missing values were handled appropriately, and categorical variables were encoded as necessary. Descriptive statistics were calculated to provide an overview of the data distribution and central tendencies.

To understand the relationship between the Food Security Index (FSI) and the various independent variables, a multiple linear regression analysis was conducted (Ningtyas et al., 2014). This statistical technique helps to quantify the effect of each independent variable on the dependent variable (FSI) while controlling for the influence of other variables. The regression model included the following independent variables: gender, marital status, education, land ownership, food crop cultivation, meal frequency, age, food source, and HDDS. The model was evaluated based on R-squared, adjusted R-squared, and the significance of individual predictors.

In addition to linear regression, a Random Forest Regressor was employed to predict the Food Security Index (FSI) and identify the most important factors influencing food security. Random Forest is an ensemble learning method that builds multiple decision trees and merges them to improve predictive accuracy and control

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overfitting. The dataset was split into training and testing sets (80% training, 20% testing) to evaluate the model's performance. The model's accuracy was assessed using metrics such as Mean Squared Error (MSE) and R-squared (R^2).

The Random Forest model provides an assessment of feature importance, indicating which variables have the most significant impact on predicting the FSI. This analysis helps to identify the key determinants of food security and provides insights into which factors should be prioritized in policy and intervention programs.

A correlation analysis was conducted to examine the pairwise relationships between all variables in the dataset. This analysis helps to identify potential multicollinearity issues and provides a preliminary understanding of the associations between different factors influencing food security.

Data visualizations, including correlation matrices and feature importance plots, were created to facilitate the interpretation of the results. These visualizations provide a clear and concise representation of the relationships between variables and the impact of different factors on food security.

By combining multiple linear regression, Random Forest regression, and correlation analysis, this study provides a comprehensive examination of the determinants of food security in rural households. The methods employed ensure a robust analysis, allowing for a deeper understanding of the complex interactions between socioeconomic factors, dietary diversity, and food security.

3. RESULTS

The analysis conducted in this study yielded several important findings regarding the determinants of food security among rural households. The results are summarized below, focusing on the outcomes of the multiple linear regression, Random Forest regression, and correlation analyses.

Multiple Linear Regression Analysis

The multiple linear regression model was used to explore the relationships between the Food Security Index (FSI) and various independent variables, including gender, marital status, education, land ownership, food crop cultivation, meal frequency, age, food source, and Household Dietary Diversity Score (HDDS). R-squared (R^2): The model explained approximately 58.1% of the variance in the FSI, with an adjusted R-squared value of 57.4%, indicating a moderate fit. Significant Predictors: The HDDS emerged

as a significant predictor of the FSI, with a strong negative relationship ($p < 0.001$) **(Table. 1).** This suggests that higher dietary diversity is associated with lower food security levels. Other variables, such as education and food source, showed weaker correlations and were not statistically significant at the 95% confidence level.

Random Forest Regression Analysis

A Random Forest Regressor model was employed to predict the FSI and determine the importance of each feature.

Model Performance: The Random Forest model achieved an R-squared value of 0.495, indicating that approximately 49.5% of the variance in the FSI was explained by the model. The Mean Squared Error (MSE) was 10.743.

Feature Importance: The feature importance analysis revealed that HDDS was the most influential factor in predicting the FSI, aligning with the results from the multiple linear regression analysis. Other important features included food source and age, while variables such as gender, marital status, education, land ownership, and meal frequency had relatively lower importance.

Correlation Analysis

The correlation analysis provided insights into the pairwise relationships between variables.

Key Correlations: The HDDS showed a strong negative correlation with the FSI (-0.69), reinforcing the finding that higher dietary diversity is associated with lower food security levels. The FSI also had negative correlations with education and food source, although these were weaker. Positive correlations were observed between HDDS and education, as well as between HDDS and food source, indicating that higher education levels and diverse food sources are associated with better dietary diversity.

Table 1. Multiple Linear Regression Results

Variable	Coefficient	Std. Error	t-value	p-value	95% C.I
Constant	40.7102	1.173	34.710	<0.001	[38.406, 43.014]
Gender	0.2948	0.286	1.032	0.302	[-0.266, 0.856]
Marital status	-0.2183	0.216	-1.011	0.312	[-0.642, 0.206]
Education	-0.1061	0.106	-1.005	0.316	[-0.314, 0.101]
Land ownership	0.0891	0.164	0.545	0.586	[-0.232, 0.410]
Food crops	-0.4816	0.288	-1.671	0.095	[-1.048, 0.084]
Meal frequency	0.3724	0.340	1.097	0.273	[-0.295, 1.039]
Age	-0.0106	0.009	-1.193	0.234	[-0.028, 0.007]
Food Source	-0.1853	0.119	-1.559	0.120	[-0.419, 0.048]
HDDS	-1.5165	0.057	-26.427	<0.001	[-1.629, -1.404]

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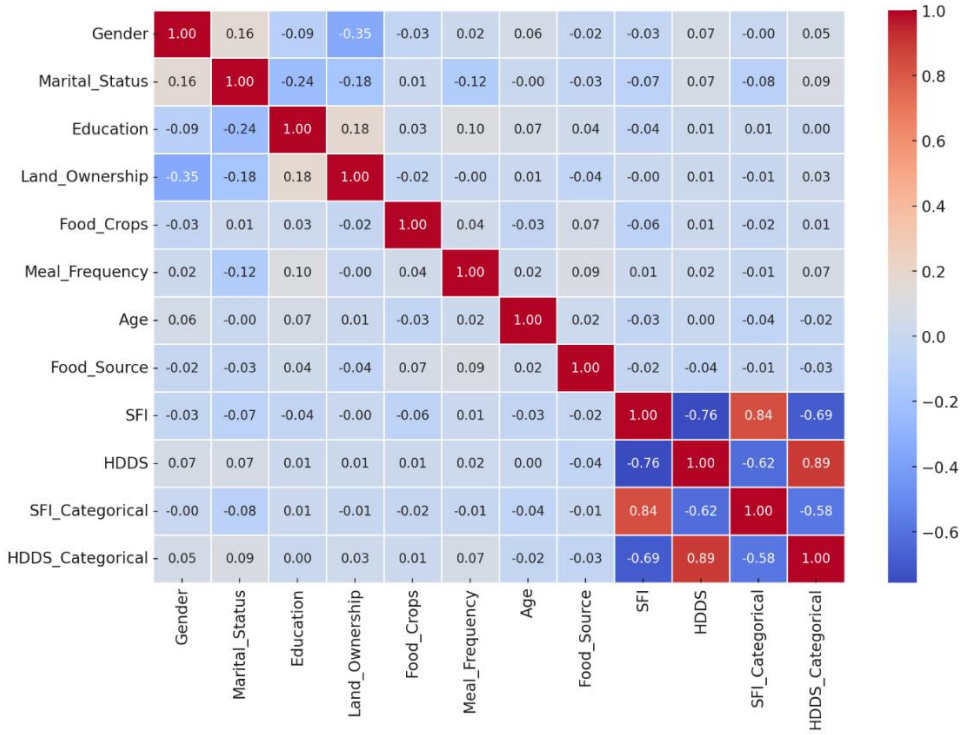

Figure 1. Correlation Matrix of Variables

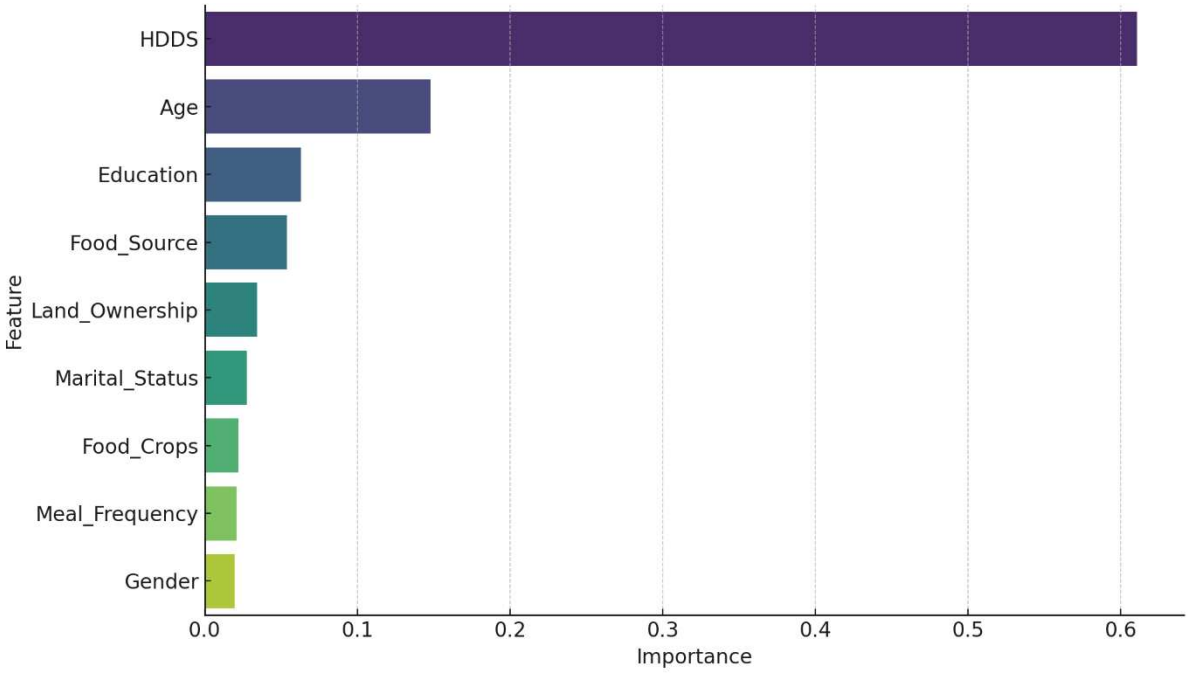

Figure 2. Feature Importances from Random Forest Regressor

4. DISCUSSION

The findings of this study provide significant insights into the determinants of food security among rural households. By analyzing various socioeconomic factors, dietary diversity, and land ownership, we have identified key variables that influence the Food Security

Index (FSI)(Cordero-Ahiman et al., 2021).The multiple linear regression analysis revealed that the Household Dietary Diversity Score (HDDS) is a significant predictor of the FSI, with a strong negative relationship. This indicates that higher dietary diversity is associated with lower food security levels, suggesting that households consuming a more varied diet may face greater challenges in securing enough food(Kishore et al., 2021). This counterintuitive result could be explained by the possibility that households striving for a more diverse diet may encounter higher costs, leading to financial strain and reduced food security. Other variables such as education, food source, and age, although not statistically significant in the multiple linear regression model, showed some level of importance in the Random Forest regression analysis (Mehraban & Ickowitz, 2021). Specifically, the feature importance analysis from the Random Forest model highlighted that HDDS, food source, and age are the most influential factors in predicting the FSI. This underscores the complexity of food security, where multiple factors interplay to affect household food security outcomes(Oyo & Kalema, 2016).The correlation analysis provided additional insights into the relationships between various socioeconomic factors and food security. Education, while showing a weak negative correlation with FSI, had a positive correlation with HDDS. This suggests that more educated households tend to have a more diverse diet, which aligns with the understanding that education improves awareness and access to nutritional information. However, the weak correlation with FSI indicates that education alone may not be sufficient to enhance food security significantly. Land-ownership, another critical factor, did not show a strong correlation with FSI. This might be due to the fact that owning land does not necessarily translate into effective utilization or productivity, especially in rural areas where access to resources and agricultural inputs may be limited. The results of this study have important policy implications(Nandi et al., 2021). Firstly, interventions aimed at improving food security should consider the complexity of dietary diversity and its impact on household food security. Efforts to enhance dietary diversity need to be accompanied by measures to reduce the financial burden on households, such as subsidies for nutritious foods or support for home gardening initiatives. Secondly, educational programs that promote nutrition and food security awareness should be strengthened, particularly in rural areas (Alhogbi et al., 2018). These

programs can empower households to make informed decisions about their diets and resource utilization. Lastly, policies should focus on improving the productivity and sustainability of land use in rural areas. Providing access to agricultural inputs, training, and support services can help landowners optimize their land for food production, thereby enhancing food security (Weiss et al., 2014).

5. CONCLUSION

This study highlights the multifaceted nature of food security in rural households, emphasizing the critical roles of dietary diversity, socioeconomic conditions, and land ownership. While HDDS emerged as a significant determinant, other factors such as education, food source, and age also play important roles. Policymakers and stakeholders must adopt a holistic approach to address food security, considering the interplay of various determinants and implementing comprehensive interventions to improve the well-being of rural communities. Further research is recommended to explore the complex interactions between these variables and to develop targeted strategies for enhancing food security.

AUTHOR CONTRIBUTIONS

Substantial contributions to conceptualization, data curation, analysis: Fitrio Deviantony, Erti Ikhtiarini Dewi, Yeni Fitria and Enggal Hadi Kurniawan. Supervision Writing-review & editing: Fitrio Deviantony, and Yeni Fitria. Manuscript revisions: Fitrio Deviantony.

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CONFLICT OF INTEREST

The authors declare no conflict of interest for this publication.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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