Food Security and Welfare of Inpari Nutri Zinc Rice Farmers in Stunting-Prone Areas of Kulon Progo Regency, Indonesia

Lestari Rahayu[1*], *Iftitah Lailatul* Hikmah [1], *Cahyo Wisnu* Rubiyanto[1], and *Oki* Wijaya[1]

[1]Agribusiness Department, Universitas Muhammadiyah Yogyakarta, Indonesia 55183

Abstract. Biofortified rice has been promoted to improve nutrition-sensitive farming in rural areas where people don't have enough food and are malnourished, including stunting. Inpari IR Nutri Zinc rice was brought to dryland areas of Kulon Progo Regency, Indonesia, where stunting is common, with the hope that it would make food more secure for families and improve the lives of farmers. A cross-sectional household survey was conducted involving 125 Inpari IR Nutri Zinc farmers selected using a census approach. Household food security was assessed using the Household Food Insecurity Access Scale (HFIAS), while household welfare status was examined through multinomial logistic regression analysis. The results show that most farm households are moderately food insecure, indicating they remain at risk despite having started using biofortified rice technology. Income and spending on food at home have a significant effect on both food security and welfare. The results of this study indicate that relying solely on biofortified rice does not automatically improve the well-being of households. To achieve this, they need to employ alternative strategies that increase income and diversify their livelihoods. Therefore, biofortification programs should be part of larger plans to strengthen rural areas in dryland regions where stunting is common. This will help the food system stay stable.

1 Introduction

Kulon Progo Regency has a cultivated land area of 6,147 hectares and a varied topography ranging from 0 to 1,000 meters above sea level. The region can be divided into three main zones. The northern area consists of highlands at 500–1,000 meters above sea level, covering the districts of Girimulyo, Kokap, Kalibawang, and Samigaluh. The central zone comprises hilly areas with elevations between 100–500 meters above sea level, including the districts of Nanggulan, Sentolo, Pengasih, and part of Lendah. The southern zone is a lowland area (0–100 meters above sea level) that includes the districts of Temon, Wates, Panjatan, Galur, and part of Lendah.

Most residents of Kulon Progo work in agriculture. In addition to farming, many households raise a small number of goats typically one or two per family. Other sources of

* Corresponding author: lestari@umy.ac.id

income include skilled labor, construction work, trading, and civil service. However, only a small proportion of residents can become civil servants, as these positions require higher levels of education. Those with limited educational backgrounds have fewer job opportunities and therefore rely mainly on income from farming or livestock to meet their household needs. This dependence leads to unstable income levels, making Kulon Progo Regency one of the areas with the highest poverty rates in the Special Region of Yogyakarta. Such economic conditions negatively affect food security and the welfare of farming households.

Low household income and food insecurity limit access to nutritious food and have long-term implications for public health, especially for children during their early growth years. Stunting is a form of growth disorder in which a child's height is significantly shorter than that of other children of the same age. Besides inadequate nutritional intake during the first 1,000 days of life, limited maternal awareness and understanding of proper nutrition and childcare practices also contribute to the persistence of stunting cases [1]

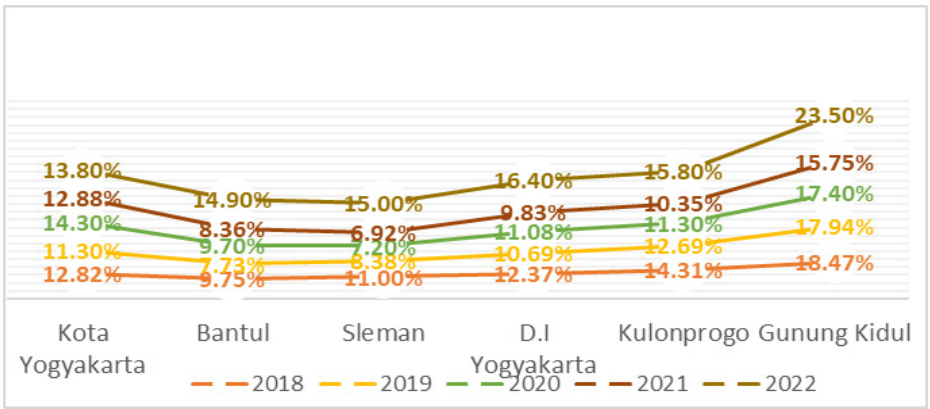

Fig. 1. Percentage of Stunting Toddlers in D.I Yogyakarta in 2018-2022

From 2018 to 2022, Figure 1 shows the changes in the percentage of stunted toddlers across the five regencies and cities in the Special Region of Yogyakarta (DIY). The data illustrate fluctuations in early childhood nutrition during this period, with certain years showing improvement while others indicated stagnation. Throughout these five years, Kulon Progo consistently recorded the highest stunting rate, reaching 15.8% in 2022, the highest in the entire province. This finding highlights Kulon Progo as the area most vulnerable to nutritional deficiencies, particularly in rural and dryland zones.

Yogyakarta City, on the other hand, had the lowest stunting rate in the region over the same period. This suggests that urban areas tend to have better access to healthcare services, sanitation, education, and nutritious food. Although several regencies have experienced a decline in stunting prevalence, the downward trend remains unstable and varies from year to year. These conditions indicate that stunting reduction efforts are not yet evenly distributed and require more region-specific interventions.

Figure 2 shows that three districts Samigaluh, Pengasih, and Lendah consistently exhibited higher stunting rates than other areas. The number of stunted toddlers in these districts has fluctuated annually, with a noticeable increase recorded in 2022.

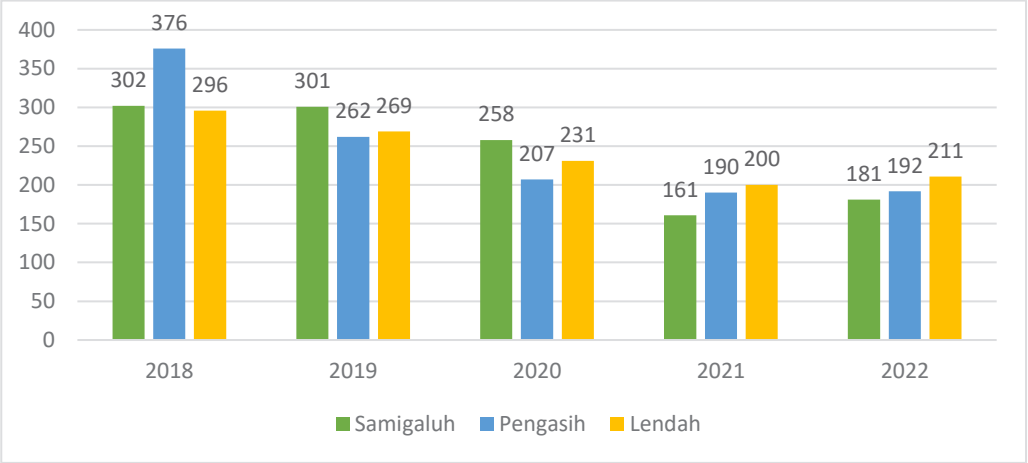

Fig 2. Number of Stunting Toddlers in Kulon Progo Regency 2018-2022

Poverty can be referred to as a symptom of the low level of welfare of farmers' households. Factors that affect the poverty rate of an area are income level, education, access to goods and services, location, geography, gender, and environmental conditions. The welfare of farmer households is related to poverty because poverty is the main problem to realize the welfare of farmer households [2,3]

Table 1. Regency/City Poverty Rate in D.I Yogyakarta Province in 2020-2022 (Percentage)

Regency/City	Number of Poor People by Regency/City		
	2020	**2021**	**2022**
Kulon Progo	18.01	18.38	16.39
Gunungjidul	17.07	17.69	15.86
Bantul	13.50	14.04	12.27
Sleman	8.12	8.64	7.74
Yogyakarta	7.27	7.69	6.62
D.I Yogyakarta	12.28	12.80	11.34

Source : BPS Kulon Progo Regency in 2022

Table 1 shows that Kulon Progo Regency has the highest poverty rate in D.I. Yogyakarta, at 16.39%. Even though there are a lot of programs to help people get out of poverty, things aren't getting better because the cost of living is going up. The government introduced Inpari IR Nutri Zinc rice as a nutrition-sensitive intervention to help with both malnutrition and poverty, with a special focus on lowering the rate of stunting [4] Food security in farming households depends on their ability to access sufficient, safe, and nutritious food, while also treating food as a source of income [5] It is closely linked to household welfare and influenced by factors such as income, education, family size, access to land, food reserves, and health conditions [5–7]

Population growth and land pressure have reduced agricultural productivity, impacting food security [8]. Based on the results of research conducted by [9], the factor of food security is the main cau Lack of local awareness and weak community institutions also contribute to food insecurity [9–10].

In 2019, Inpari IR Nutri Zinc rice was introduced to improve nutrition by adding more zinc to the rice. Zinc helps with growth, metabolism, and the immune system. A lack of zinc can lead to stunted growth and developmental problems [3, 12].

Field observations show that the planting area in Lendah, Pengasih, and Samigaluh shrank between 2022 and 2023 (**Table 2**), even though seed subsidies were available. This was

because farmers didn't know how healthy rice was. The government has helped this program by giving it seeds, fertiliser, and extension services. Table 3 shows that rice's productivity peaked in 2021 but declined in 2022 (Agriculture and Food Security Office, 2022).

Table 2. Realization of Inpari IR Nuri Zinc Rice Seed Assistance 2023

Year	Land Area (ha)	Production (tons)	Productivity (ku/ha)
2021	25	162.9	65.15
2022	10	61.9	61.85

Source : Kulon Progo Regency Agriculture and Food Security Office 2021-2022

The content of Inpari IR Nuri Zinc Rice has significant health benefits. It is hoped that the production of Inpari IR Nuri Zinc Rice can make a great contribution to the household income of farmers in the region. Low productivity causes farmers to prefer to consume their own produce rather than sell it. As a result, farmers often experience a shortage of rice before harvest and have to buy it from stalls or neighbors, which ultimately has an impact on the poverty level and food security of farmers' households. Facing this problem, research on Food Security and Welfare of Inpari IR Nurtizinc Rice Farmers is an urgent need.

This study aims to: 1) find out the food security of households of inpari IR nutri zinc rice farmers in stunting-prone areas of Kulon Progo Regency, 2) find out the welfare of households of inpari IR nutri zinc rice farmers in stunting-prone areas of Kulon Progo Regency, 3) find out the factors that affect the food security of households of inpari IR nutri zinc rice farmers in stunting-prone areas of Kulon Progo Regency

2 Methodology

This research utilised a descriptive quantitative approach to deliver a precise and organised summary of the socio-economic attributes and food security condition of Inpari IR Nutri Zinc rice farmers. The methodology sought to evaluate field data impartially, ensuring that the conclusions remained confined to the study population. . The sample consisted of 125 farmers who cultivated Inpari IR Nutri Zinc rice in three sub-districts of Kulon Progo Regency, selected through a census technique.

This research collected both primary and secondary data sources. The researchers gathered the primary data through structured interviews using questionnaires. These data included information on the respondent's identity, number of family members, farming experience, land ownership, production quantity, food reserves, and selling price. In addition, the researchers obtained responses to the Household Food Insecurity Access Scale (HFIAS) questionnaire as part of the primary data collection process [10–12]. The researchers obtained secondary data from relevant government agencies. These data covered demographic conditions, agricultural productivity, poverty rates, and the prevalence of stunting in Kulon Progo Regency. The researchers processed and analyzed all data quantitatively using descriptive statistics and econometric techniques. Before presenting the analytical results, the study introduces the main equations used to calculate household income, expenditure, welfare, and food security levels. These formulations provide a structured basis for the econometric model and help explain how each household characteristic influences food security outcomes [15].

Household Income

Household Income = Farming Income Inpari IR Nutri Zinc Rice + Farming Income other than Inpari IR Nutri Zinc Rice + Non-Farming Income + Non-Agricultural Income

Household Expenses

$$TP = Pp + Pn \quad (1)$$

Information:
TP : Total Household Expenditure of Farmers (IDR/year)
Pp : Food expenditure (IDR/year)
Pn : Non-food expenses (IDR/year)

(1) Food security with HFIAS indicators[10][11]
Category 1: Severe food insecurity if [Q5a=3 or Q6a=3 or Q7a=1 or Q7a=2 or Q7a=3 or Q8a=1 or Q8a=2 or Q8a=3 or Q9a=1 or Q9a=2 or Q9a=3]
Category 2: Moderate food insecurity if [(Q3a=2 or Q3a=3 or Q4a=2 or Q4a=3 or Q5a=1 or Q5a=2 or Q6a=1 or Q6a=2) and Q7=0 and Q8=0 and Q9=0.
Category 3: Mild food insecurity if [(Q1a=2 or Q1a=3 or Q2a=1 or Q2a=2 or Q2a=3 or Q3a=1 or Q4a=1) and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0].
Category 4: Food resistant if [(Q1a=0 or Q1a=1) and Q2=0 and Q3=0 and Q4=0 and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0] [13]

(2) Household Welfare

$$\text{Expenditure/capita/month (Rp)} = \left(\frac{(Expenditure/year(IDR))}{(number\ of\ family\ members)}\right) : 12 \quad (2)$$

(3) *Multinominal logistics*

$$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6 + D1 + D2 \quad (3)$$

Information:

Y : Response variables 1 (heavy food incontinence), 2 (moderate food incontinence), 3
β0 :Constant
β : Regression coefficient parameter
X1 : Household income (IDR/month)
X2 : Number of family members (people)
X3 : Land area (m2)
X4 : Household expenses (Rp/month)
X5 : Food reserves (Kg)
X6 : Head of household education (1 = No School, 2 = Elementary, 3 = Junior High School, 4 = High School)
Dummy 1 : Well-being (0 = Poor, 1 = Not Poor)
Dummy 2 : Stunting (0 = no, 1 = Yes)

3 Results and Discussion

3.1 Food Security

Food security is defined through three interrelated dimensions: availability, accessibility, and utilization of food. In this study, household-level food security was assessed using the Household Food Insecurity Access Scale (HFIAS) and the Household Hunger Scale (HHS), which focus on capturing respondents' experiences and perceptions of food access and consumption challenges [10,11]

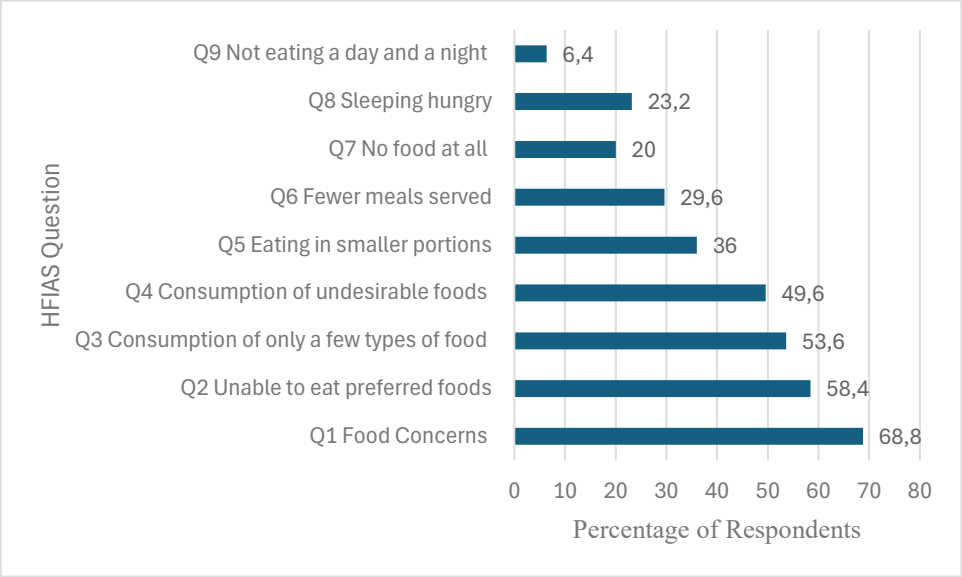

Fig. 3. HFIAS and HHS assessment results

The researchers chose the HFIAS and HHS instruments because they are useful and accurate for measuring household food insecurity based on how people feel about it [10]. According to the survey results (Figure 3), 94% of farmers said "Yes" to the first question, which means that they worry every day about whether they have enough food. This high percentage indicates that most farming households regularly worry about whether their food supply will be adequate. Furthermore, 52% of respondents answered "Yes" to the second question, suggesting that household members often feel the need to adjust the types of food consumed, possibly by limiting dietary diversity. This response pattern shows that many farming families struggle to meet their nutritional needs consistently and adequately. In addition, 45% of respondents answered “Yes” to the third question, which further confirms that households often rely on coping mechanisms due to limited access to food. On the other hand, 14% to 17% of respondents answered “No” to questions 7, 8, and 9. These answers suggest that some households are still able to fulfill their basic food needs and have not yet reached the most critical stage of food insecurity.

Table 3 shows that 40.8% of households were food secure, while 59.2% experienced food insecurity, consisting of 11.2% mildly food insecure, 11.2% moderately food insecure, and 36.8% severely food insecure. The proportion of food-secure and severely food-insecure households differs by only 4.0 percentage points, indicating a high level of vulnerability among farming households. Despite the introduction of Inpari IR Nutri Zinc rice, a substantial share of households continues to experience unstable access to adequate food. This finding suggests that the adoption of biofortified rice alone is insufficient to address food insecurity in stunting-prone rural areas**.** . Food security in these homes depends on more than just what they grow; it also depends on how much money they make, how much they spend on food, and how they make a living. This supports previous studies [10,14], which found that food security is closely linked to socioeconomic factors, including access to income and household resilience

Table 3. Food security level

No	Status	Farmer	Percentage (%)
1	Food Resistant	51	40.80
2	Mild food prone	14	11.20
3	Moderate food incontinence	14	11.20
4	Heavy food prone	46	36.80
Total		125	100

3.2 Welfare

The researchers assessed the welfare of Inpari IR Nutri Zinc rice farmers in Kulon Progo Regency by calculating monthly household expenditure per family member. This approach follows the welfare classification standard set by Statistics Indonesia.

Figure 4 shows that 43.14% of food-secure farmer households or 22 households are still classified as poor. Interestingly, the same number of poor households (47.83%) also appears in the severe food insecurity category. This finding indicates that poverty exists across both food-secure and food-insecure groups. Differences in household size explain this pattern. Households with more people tend to spend less per person, which puts them in the poor category even if they say they have enough food. So, the number of people in a family is a big factor in figuring out how well-off a household is.

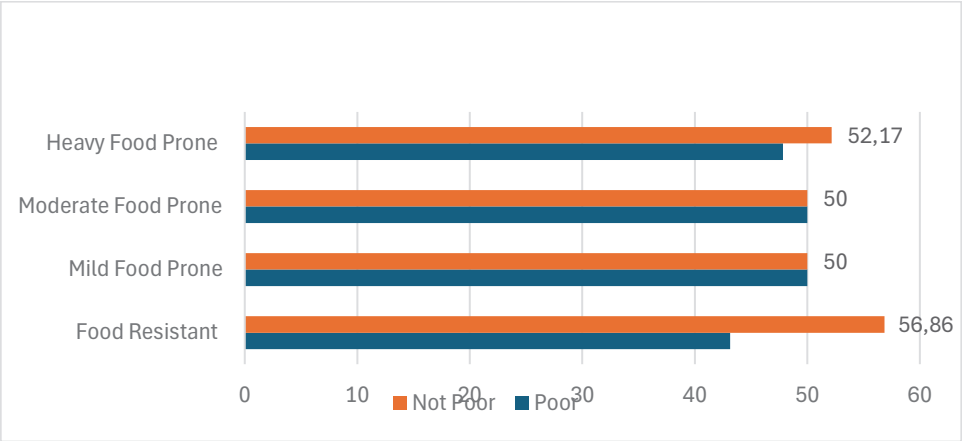

Fig 4. Household welfare of inpari IR nutri zinc rice in Kulon Progo Regency

Food expenditure is the cost incurred by a person or a household to meet their food needs in the form of rice, vegetables, meat, fruits, kitchen spices, snacks, and drinks. Meanwhile, non-food expenditures are costs incurred to meet needs outside of food such as lighting and fuel, taxes, communication, education costs, bathroom needs, health costs, and social activities.

Based on Table 4, the total expenditure of farmer households in Kulon Progo Regency which dominates food expenditure with a total of IDR. 7,882,262. Food expenditure is influenced by the number of family members, the more family members, the more expenses will be incurred. Farmers in Kulon Progo Regency have the highest food expenditure to buy side dishes because farmers grow food such as rice, vegetables, and chili. Therefore, the

expenditure on buying rice and vegetables is small because it is not every day to buy vegetables they are planted in their own garden

Table 4. Food and non-food expenditure of rice farmer households per year

Category	Main Components	Amount (IDR)	Percentage (%)
Food Expenditure	Side dishes, kitchen spices, vegetables, drinks, cigarettes, snacks, fruits	7,882,262	100
Major items	Side dishes (28.19%), spices (23.56%), drinks (12.95%), cigarettes (15.86%)		
Non-Food Expenditure	Fuel, education, daily necessities, communication, tax, clothing, healthcare, social	7,834,958	100
Major items	Fuel (42.20%), education (19.03%), daily needs (11.36%), communication (9.84%)		
Total Household Expenditure		**15,717,220**	

3.3 Characteristics of Farmers Related to Food Security

3.3.1 Age

Table 5 shows that farmers head 56.86% of food-secure households under 50 years old, while those over 50 years old head 74.19% of severely food-insecure households. This suggests that younger farmers are more resilient in food access. Similar findings were reported by [14], who found that younger household heads had better food security outcomes due to higher adaptability and productivity.

Table 5. Age and food security

Age (Years)	Food Resistant		Mild food prone		Moderate food incontinence		Heavy food prone	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
30-36	3	5.88	1	7.14	1	7.14	4	8.70
37-43	5	9.80	2	14.29	0	0.00	6	13.04
44-50	11	21.57	2	14.29	5	35.71	8	17.39
51-57	10	19.61	1	7.14	2	14.29	7	15.22
> 57	22	43.13	8	57.14	6	42.86	21	45.65
Total	51	100	14	100	14	100	46	100

3.3.2 Gender

Table 6 shows that most food-secure farmers are male (82.35%), and men also dominate the food-insecure group (84.78%). This indicates that men are more involved in farming activities that require physical strength. Meanwhile, women tend to participate more in planting and harvesting. The study also finds that male farmers tend to be more effective at maintaining food security. This supports the findings of [12], which state that when women lead households, limited work roles can hinder their ability to meet their food needs.

Table 6. Gender and food security

Gender	Food Resistant		Mild food prone		Moderate food incontinence		Heavy food prone	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Man	42	82,35	12	85,71	12	85,71	39	84,78
Woman	9	17,65	2	14,29	2	14,29	7	15,22
Total	51	100	14	100	14	100	46	100

3.3.3 Number of Family

Among the four categories of food security, all were dominated by households with three family members (**Table 7**). This is because the influence of different family members on the family economy will affect food security. The more family members, the more they have to feed. However, if other family members join in the work, this can help increase the food security of farmers' households.

Table 7. Number of family members and food security

Number of family members	Food Resistant		Mild food prone		Moderate food incontinence		Heavy food prone	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
1	14	27.45	2	14.29	5	35.71	14	30.43
2	13	25.49	7	50.00	2	14.29	13	28.26
3	13	25.49	4	28.57	5	35.71	14	30.43
4	14	15.69	1	7.14	2	14.29	5	6.52
Total	51	100	14	100	14	100	46	100

3.3.4 Education

Table 8. Education level and food security

Education	Food Resistant		Mild food prone		Moderate food incontinence		Heavy food prone	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
SD	31	60.78	6	42.86	6	42.86	24	52.17
JUNIOR	10	19.61	6	42.86	4	28.57	7	15.22
SMA	9	17.65	1	7.14	3	21.43	15	32.61
PT	1	1.96	1	7.14	1	7.14	0	0.00
Total	51	100	14	100	14	100	46	100

Table 8 shows that the majority of farmers in all food security categories have only finished elementary school. 54.9% of people in the food-secure group finished elementary school, while only 47.8% of people in the severe food insecurity group did. This suggests that farmers typically have limited educational attainment. Low education may limit farmers' ability to adopt innovation and improve household food management. In contrast, farmers with higher education tend to be more responsive to agricultural technology and more aware

of the importance of nutritious food. This supports the findings of [15], who stated that higher education accelerates farmers' adoption of innovations and technology

3.3.5 Land Ownership

The land area in the four food security categories shows that the land area that dominates in the food security category in the range of 501-1000 m² is 37.25%. Meanwhile, for the category of food insecurity, heavy land area dominates in the range of 100-500 m² by 36.96% (**Table 9**). The area of land can affect the farming costs that must be incurred and the amount of work involved. The more land owned by farmers, the higher the production and income.

Table 9. Land area and food security

Land Area (m²)	Food Resistant		Mild food prone		Moderate food incontinence		Heavy food prone	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
100 - 500	15	29.41	4	28.57	3	21.43	17	36.96
501 - 1000	19	37.25	6	42.86	7	50.00	14	30.43
1001 - 1500	6	11.76	0	0.00	1	7.14	6	13.04
1501 - 2000	8	15.69	2	14.29	2	14.29	3	6.52
Above 2000	3	5.88	2	14.29	1	7.14	3	6.52
Total	51	100	14	100	14	100	46	100

3.3.6 Income

Table 10 shows that 23.53% of households with sufficient food have an income between Rp 2,100,001 and Rp 3,000,000. On the other hand, 67.39% of households that are very food insecure have an income of less than Rp 1,000,000.

Table 10. Income and food security

Revenue (IDR)	Food Resistant		Mild food prone		Moderate food incontinence		Heavy food prone	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
< 999,999	0	0.00	0	0.00	2	14.29	31	67.39
1,000,000-2,100,000	7	13.73	5	35.71	5	35.71	11	23.91
2,100,001-3,200,000	12	23.53	3	21.43	4	28.57	2	4.35
3,200,001-4,300,000	9	17.65	1	7.14	1	7.14	1	2.17
above 4,300,000	23	45.09	5	35.71	2	14.29	1	2.17
Total	51	100	14	100	14	100	46	100

This shows that the amount of money a family makes has a significant impact on the safety of their food. People who make more money can buy a wider variety of healthy foods.Farmers grow rice and vegetables, which are basic foods, but they still need money to buy drinks and protein-rich foods. A lot of farmers grow rice and vegetables, which are basic foods, but they still need money to buy drinks and protein sources.. They raise animals and plant more crops to make their lives better.. This pattern supports previous research [5], which highlights income as a key factor influencing both access to food and the quality of household nutrition

3.4 Factors Affecting Household Food Security

This study examines various socioeconomic and demographic factors that may impact household food security in areas prone to stunted growth. The variables examined include income, number of family members, household expenses, land size, food reserves, education, welfare status, and location (zone). These factors are evaluated using multinomial logistic regression to explore their relationship with different levels of food insecurity.

Table 11. Factors Affecting Household Food Security

Variable	B (Food Secure)	Sig.	B (Mild Insecure)	Sig.	B (Moderate Insecure)	Sig.
Intercept	-0.475	0.931	-14.452	0.000***	0.874	0.875
Income (X1)	0	0.000***	0	0.000***	0	0.000***
Family Members (X2)	0.363	0.379	0.368	0.346	0.139	0.743
Expenses (X3)	0.00001	0.001***	0.00001	0.001***	0.00001	0.033***
Land Area (X4)	0.001	0.377	0.001	0.486	0.001	0.862
Food Reserves (X5)	0.002	0.31	-0.001	0.63	0.001	0.696
Education = 1 (No school)	-2.772	0.515	12.229	0.000***	-20.59	0.997
Education = 2 (SD)	-0.56	0.894	15.143	0.000***	-1.411	0.733
Education = 3 (SMP)	-0.477	0.909	14.783	0.000***	-2.246	0.589
Education = 4 (SMA)	-2.019	0.638	14.969	–	-2.596	0.543
Welfare = 0 (Poor)	-0.536	0.639	-0.618	0.591	-0.424	0.694
Zone = North (1/0)	1.015	0.365	1.411	0.207	-0.819	0.541
Zone = Middle (1/0)	-1.488	0.582	-2.4	0.362	-1.667	0.567

Model Fit (−2 Log Likelihood)	322.194	Lower value indicates better model fit
Chi Square	143.210	Model is statistically significant
Nagelkerke	0.738	Moderate explanatory power

The model fit results in Table 11 indicate that the regression model is statistically significant ($p < 0.05$), meaning it is suitable for explaining variations in food security status. The lower value of the −2 Log Likelihood suggests a better fit between the model and the observed data. This confirms that the selected independent variables collectively provide meaningful predictive power in explaining the differences in household food security levels. The Nagelkerke R^2 value of 0.738 indicates that the model explains a substantial portion of the variation in food security status (Table 11). The model fitting test in Table 14 also confirms the regression's robustness ($p = 0.000$), validating its use in identifying key determinants of household food security among Inpari IR Nutri Zinc rice farmers.

The multinomial logistic regression results indicate that household income and spending have a significant impact on food security status. Table 11 shows that household income has a positive and statistically significant effect ($p < 0.01$) on the likelihood of a household being in the food-secure, mildly insecure, or moderately insecure groups. As income rises, households increase their purchasing power, which in turn lowers the risk of food insecurity.

This result supports earlier findings that identify income as a key factor in determining household access to food and overall nutritional adequacy [5].

Additionally, household expenditure has a significant influence ($p < 0.01$) on both food-secure and mildly food-insecure households. Higher expenditure, especially on food, reflects a household's ability to afford nutritious and diverse food, thereby increasing its food security status. Education also contributes significantly, particularly in households classified as mildly food insecure. The data show that households led by individuals with higher education levels are more likely to move out of food insecurity ($p < 0.01$). Educated household heads tend to be more receptive to innovation and better informed about nutrition and food management. This supports previous research emphasizing the role of education in improving food security outcomes [15]. On the other hand, variables such as family size, food reserves, land area, and location did not show a statistically significant effect in this model. However, these factors remain relevant in the rural socio-economic context and may serve as supporting variables for household food security in broader analyses.or feasible

4 Conclusion

This study shows that most households in the dryland areas of Kulon Progo Regency, which grow Inpari IR Nutri Zinc rice, are still food insecure, even after switching to biofortified rice. Although 40% of households are food secure, almost half (48.8%) remain below the poverty line set by BPS. These results suggest that introducing nutrition-sensitive agricultural innovations alone is insufficient to improve the economic well-being of farming households. The analysis further reveals that household income and expenditure are the most significant factors influencing food security. Other factors, including food reserves and the scale of rice production, also contribute to how well families can meet their daily food needs.

The researchers emphasize that rural households must strengthen their economic resilience to achieve lasting food security. They also suggest that policymakers add biofortification programs to their plans for overall rural development, especially in dryland areas where stunting is common. This will improve nutrition and farmers' lives in the long term.

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