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ARTICLE

The Impact of Inpari Nutri Zinc Rice on Farmer Welfare and Food Security in Stunting-Prone Bantul, Indonesia

Farhanah Khairunnisa, Lestari Rahayu* , *Zuhud Rozaki* , *Cahyo Wisnu Rubiyanto

Department of Agribusiness, Universitas Muhammadiyah Yogyakarta, Yogyakarta 55183, Indonesia

ABSTRACT

Indonesia has a new variety of rice, namely Inpari Nutri Zinc rice. Bantul Regency is one of the areas for developing this rice, one of which is in Imogiri District. Inpari Nutri Zinc rice is a functional food to overcome the high stunting rate in Imogiri District. In 2023, Imogiri District had the highest number of stunted toddlers in Bantul Regency, reaching 434 toddlers. In addition, Imogiri District experienced crop failures which caused farmers' welfare issues such as food insufficiency and poverty. The research problems aim to: (1) identify the income and expenditure of Inpari Nutri Zinc rice farming households, (2) analyze the welfare of these households, (3) analyze food security, and (4) analyze the factors that influence food security. This study used a census technique, and 125 respondents were selected. The data were analyzed quantitatively, including GSR (Good Service Ratio) to analyze the welfare of farmer households, HFIAS (Household Food Insecurity Access Scale) with 9 questions related to the availability, quality, and quantity of food. Nutritional Adequacy Rate was used to determine food quantity and Expected Food Pattern to determine food quality, as used in national nutrition recommendations and by the Indonesian Food Security Agency. Binary logit analysis was used to identify factors affecting food security, analyzed using SPSS. The results showed that 56.80% of farmers were food secure. Most (53.60%) of farmers were categorized as less prosperous, with poor food quantity and quality. Expenditure, education, and gender were identified as factors affecting food security among farmer households.

*CORRESPONDING AUTHOR:
Lestari Rahayu, Department of Agribusines, Universitas Muhammadiyah Yogyakarta, Yogyakarta 55183, Indonesia;
Email: lestari@umy.ac.id

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1. Introduction

In 2019, the Ministry of Agriculture issued a new variety of rice, namely Inpari Nutri Zinc rice, which was released by the Ministry of Agriculture through the Decree of the Minister of Agriculture Number 168/HK.540/C/01/2019. Inpari Nutri Zinc rice is one of the new superior functional varieties from rice breeding to meet food needs in the form of rice with zinc content [1]. The function of Zinc is for wound healing, maintaining body fertility, can increase body immunity, and is involved in protein synthesis. Therefore, if humans lack Zinc, their growth will be disrupted, with the major impact being a height that is lower than normal. The Zn content in Inpari Nutri Zinc rice reaches 34.51 ppm, when compared to the Ciherang variety which only contains 24.06 ppm of Zn. This means that Inpari Nutri Zinc rice is a functional food intended to prevent nutritional deficiencies [2]. It is hoped that this functional food can contribute to increasing national food security and meeting the nutritional needs of the population [3].

Yogyakarta has an average prevalence of stunting of 21% in toddlers spread across five districts. The development and distribution of Inpari Nutri Zinc rice seeds were carried out in areas prone to stunting [4]. In 2023, the Yogyakarta Special Region Provincial Government has determined the data of prospective farmers and land recipients of Inpari Nutri Zinc rice assistance in three districts. Bantul Regency has the largest land area, namely 100 hectares, and the largest recipient of seeds, namely 2,500 kg. This shows that Bantul is an area prone to stunting. Imogiri District is one of the districts that has planted Inpari Nutri Zinc rice in Bantul Regency. In 2022, this area experienced a failed rice crop, with a difference in planting and harvesting area reaching 650.16 hectares, which increased to 765.75 hectares in 2023.

In 2023, Imogiri District also had the highest number of stunted toddlers in Bantul Regency, reaching 434 children in 2023. Stunting in toddlers is caused by various factors that are often associated with poverty, such as lack of nutritional intake, health problems, poor sanitation, and environmental conditions [5, 6]. Risk factors for stunting include income, number of family members, father's height, mother's height, and exclusive breastfeeding [7–9]. Based on several opinions, it can be concluded that economic conditions affect food security in a household, thus affecting stunting rates due to unmet nutrition. There are three components of food security, namely availability, distribution, and consumption. In addition, Imogiri District is ranked third based on the number of families registered in the Integrated Social Welfare Data, which contains data sources for 40% of the population with the lowest welfare status. These low socio-economic conditions limit access to nutritious food for children [10, 11]. The welfare of farmer households is seen from the farmer's ability to meet his/her income to meet the needs of clothing, food, shelter, health and education. This study aims to analyze the effect of developing Inpari Nutri Zinc as a functional food on farmer welfare and food security in stunting-prone areas in Bantul Regency, Indonesia. Based on this problem, it is necessary to formulate a comprehensive solution to address the issue of stunting and increase food security in the region.

2. Literatur Riview

Indonesia is a country with a very large agricultural sector; therefore, the livelihoods of the majority of the Indonesian population depend on agriculture [12]. In addition, the role of the agricultural sector in Indonesia is very important because the agricultural sector plays a major role in providing food needs. Rice is Indonesia's staple food to meet nutritional and energy needs [13]. However, currently the problem of nutrition in Indonesia is still a major challenge [14]. To overcome this, the Indonesian government developed Inpari Nutri Zinc rice as a functional food to overcome stunting. Inpari Nutri Zinc rice is used as a functional food to improve food quality while overcoming stunting because this rice has a higher zinc content than other rice [15].

Functional food is food that contains nutrients and

can increase immunity and reduce the risk of chronic diseases [16]. Stunting is a condition where someone experiences malnutrition due to zinc deficiency or because someone has an illness [17]. Not meeting a person's nutritional needs can also be caused by insufficient food availability and poverty in a household [18].

Food availability can indicate the condition of food security in a household [19]. Household food security of farmers is the ability of farmers to produce food through their agricultural products so that they are able to meet food availability, food access, and good food quality for their household food needs [20]. The development of Inpari Nutri Zinc rice is also expected to increase the food security of farmer households because in addition to having the advantage of high zinc content, this rice is also pest resistant and has high productivity. In addition, increasing income from agricultural products can increase farmers' access to various resources such as education, health, and technology [21]. The welfare of farmer households can be seen from sufficient income, good quality of life such as health, education, security, and easy access to basic needs [22].

3. Materials and Methods

3.1. Study Location

This study was conducted in sub-districts that had planted Inpari Nutri Zinc rice and experienced crop failure. As seen in **Figure 1**, This study covered three villages, namely Kebonagung (west zone), Wukirsari (north zone), and Selopamioro (south zone). In addition, these locations were designated as red zones for stunted toddlers in Bantul Regency and also included sub-districts that were classified as economically poor.

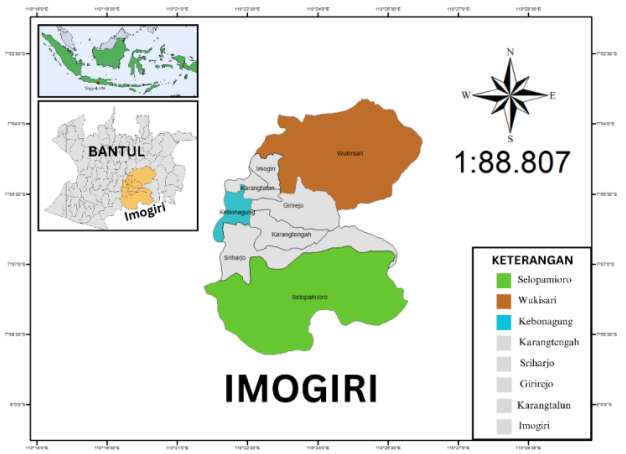

Figure 1. Location of Inpari Nutri Zinc rice development area.

3.2. Sampling Procedure and Data Collection

Respondents in this study were Inpari Nutri Zinc rice farmers who were members of farmer groups in Bantul Regency. Respondents were selected based on farmers who had previously planted Inpari Nutri Zinc rice. A total of 125 Inpari Nutri Zinc rice farmers from Imogiri District were selected as respondents. Respondents were determined using a census technique. Primary data collection was conducted through interviews with respondents and observations. Interview data included name, age, education level, number of family members, farming experience, land area, land type, income, expenditure, food reserves, and questions from the HFIAS instrument, weight, height, and 2 × 24-hour food recall (**Table 1**).

Table 1. Type of interview data collected.

Variable	Data
Income	Inpari Nutri Zinc rice income, on farm income, off farm income, and non farm income
Expenditure	Food expenditure and non-food expenditure
GSR (Good Service Ratio)	Food expenditure and non-food expenditure
HFIAS (Household Food Insecurity Access Scale)	Food availability, food quantity, and food quality
Nutritional Adequacy Rate	Weight, height, food ingredients, type of food, amount of food, weight of food ingredients, number of members consuming
Expected Food Pattern	Food ingredients, type of food, quantity of food, weight of food ingredients
Logit Binary	Age, number of family members, land area, income, expenditure, food reserves, education, gender, type of land.

Observation data include the condition of the building, the condition of the area, and the condition of the land. Secondary data was obtained from local related agencies, such as the Bantul Regency Food Security and Agriculture Service, the Imogiri District Agricultural Extension Agency, the Bantul Regency Health Service, and the Bantul Regency Social Service.

3.3. Analytical Technique

The data analysis techniques used in this study include household income and expenditure, food security with the HFIAS instrument, food quantity and quality with the analysis of Nutritional Adequacy Rates, Expected Food Patterns, welfare analysis using the Good Service Ratio (GSR), and food security factor analysis using binary logit, which includes 9 variables, namely age, number of family members, land area, income, expenditure, food reserves, education, gender, and land type.

3.3.1. HFIAS (Household Food Insecurity Access Scale)

HFIAS (Household Food Insecurity Access Scale) is a measuring tool used to assess the level of food security (food insecurity) at the household level [23]. This scale was developed by USAID (United States Agency for International Development) through the Food and Nutrition Technical Assistance (FANTA) project [24]. HFIAS is used to measure household access to food availability in terms of both quality and quantity. This analysis was conducted with 9 question instruments related to three main aspects of food security, namely food availability, food quality, and food quantity [25].

3.3.2. Nutritional Adequacy Rate

The Nutritional Adequacy Rate is used to analyze the adequacy of a person's nutritional needs in terms of energy and protein to meet basic metabolic needs, which includes the Energy Adequacy Rate and Protein Adequacy Rate [26]. The calculation of the Nutritional Adequacy Rate is used in national nutritional recommendations in Indonesia, which are adjusted to the population conditions, habits, and environment in Indonesia. According to the Regulation of the Minister of Health of the Republic of Indonesia No. 28 of 2019 concerning the Nutritional Adequacy Rate, the daily Adequacy Rate for Indonesians is at least 2,000 kcal capita^{-1} day^{-1} and the Protein Adequacy Rate is at least 52 grams capita^{-1} day^{-1} [27].

3.3.3. Expected Food Pattern

The Expected Food Pattern is an analysis designed by the government through the Indonesian Food Security Agency. This analysis is used to measure the quality of community food consumption based on the diversity and balance of consumption of various food groups [28]. This concept was developed to encourage healthy and nutritious eating patterns, while ensuring food security at the individual, household and community levels [29].

The Expected Food Pattern groups food into several categories, such as grains, tubers, oily fruits/seeds, oils and fats, sugar, animal foods, nuts, fruits and vegetables. The assessment is carried out on a score scale of 0–100, where a score approaching 100 indicates a consumption pattern that is increasingly ideal and in accordance with the balanced nutrition guidelines set by the government [30, 31].

3.3.4. Good Service Ratio

Good Service Ratio (GSR) is the ratio between food expenditure and non-food expenditure which is used as an indicator of the level of household welfare [32]. GSR shows the pattern of expenditure allocation, where a higher ratio indicates that most of the household income is used to meet food needs [33]. This analysis is done by calculating the comparison between food and non-food expenditure; if the GSR comparison figure > 1, it means that expenditure for food is greater than expenditure for non-food, which means less prosperous. While if the GSR comparison figure = 1, it means prosperous and if <1 means more prosperous [34].

3.3.5. Binary Logit

Binary Logit Analysis is a statistical method used to model the relationship between an independent variable and a binary dependent variable, which has two categories, such as "yes/no" [35]. In this study, food security is used as the dependent variable, while the independent variables consist of 9 variables. X1 is the age of the head of the household (years), X2 is the number of family members (people), X3 is the area of agricultural

land (m^2), X4 is household income (IDR per year), X5 is household expenditure (IDR per year), X6 is food reserves (kg), X7 is the level of education of the head of the household (1 = elementary school, 2 = junior high school, 3 = high school, 4 = higher education), Dummy 1 is gender (1 = male, 0 = female), Dummy 2 is the type of land (1 = rainfed, 0 = irrigated) [36]. The binary logit analysis technique was developed by statistician David R. Cox in 1958, later known as the logistic regression model or logit. This analysis technique is widely used internationally in various fields of science and research, including economics and social sciences. This method uses a logistic function to predict the probability of an event based on independent variables [37]. This model produces coefficients that represent the change in the log-odds of the probability of an event for each one-unit increase in the independent variable, with the odds ratio as the primary interpretation [38].

4. Results

4.1. Respondent Characteristics

The majority of Inpari Nutri Zinc rice farmers are 60–68 years old. The productive working age in Indonesia ranges from 15 to 64 years. This means that most Inpari Nutri Zinc rice farmers in Imogiri District are no longer of productive age [39, 40]. In **Table 2**, it can be seen that more than 90% of Inpari Nutri Zinc rice farmers are male. In the agricultural sector, there are several activities that require more strength such as hoeing, spraying, plowing, and others, which of course men have greater physical abilities than women [41, 42].

Table 2. Respondent characteristics.

Characteristics		Selopamioro		Wukirsari		Kebonagung	
		Σ	%	Σ	%	Σ	%
Age (year)	42–50	8	25.00	11	15.49	4	18.18
	51–59	3	9.38	15	21.13	5	22.73
	60–68	6	18.75	28	39.44	8	36.36
	69–77	13	40.63	15	21.13	5	2.73
	78–86	2	6.25	2	2.82	0	0.00
Gender	Woman	30	93.75	64	92.96	20	91.20
	Man	2	6.25	7	7.04	2	8.80
Education level	No School	4	12.50	9	12.70	2	9.10
	Elementary School	15	46.90	35	49.30	4	18.20
	Junior High School	6	18.80	11	15.50	5	22.70
	Senior High School	6	18.80	14	19.70	10	45.50
	Higher Education	1	3.10	2	2.80	1	4.60
Land area (m^2)	100–1000	15	46.90	24	33.80	4	18.20
	1001–2000	13	40.60	21	29.60	4	18.20
	2001–3000	3	9.40	11	15.50	4	18.20
	>3000	1	3.10	15	21.10	10	45.50
Number of family members	1–2	10	31.00	28	39.40	9	40.90
	3–4	17	53.00	31	43.70	9	40.90
	5–6	4	13.00	10	14.10	4	18.20
	7–8	1	3.00	2	2.80	0	0.00
Income	IDR 0–20,000,000	2	6.25	15	21.13	2	9.09
	IDR 20,000,001–40,000,000	5	15.63	7	9.86	5	22.73
	IDR 40,000,001–60,000,000	5	15.63	8	11.11	4	18.18
	IDR 60,000,001–80,000,000	6	18.75	5	7.04	0	0.00
	IDR 80,000,001–100,000,000	2	6.25	7	9.86	1	4.55
	IDR >100,000,000	12	37.50	29	40.85	11	50.00

Table 2. *Cont.*

Characteristics		Selopamioro		Wukirsari		Kebonagung	
		Σ	%	Σ	%	Σ	%
Expenditure	IDR 0–20,000,000	21	65.63	64	90.14	17	77.27
	IDR 20,000,001–40,000,000	9	28.13	7	9.86	5	22.73
	IDR 40,000,001–60,000,000	2	6.25	0	0.00	0	0.00
	IDR 60,000,001–80,000,000	0	0.00	0	0.00	0	0.00
	IDR 80,000,001–100,000,000	0	0.00	0	0.00	0	0,00
Food reserve	0	11	34.40	22	31.00	2	9.10
	1–201	12	37.50	18	25.40	3	13.60
	202–402	2	6.30	8	11.30	2	9.10
	403–603	3	9.40	6	8.50	2	9.10
	604–804	1	3.10	3	4.20	3	13.60
	>804	3	9.40	14	19.70	10	45.50
Land type	Irrigation	5	15.60	16	22.50	22	100.00
	Rainfed	27	84.38	55	77.50	0	0.00

The majority of Inpari Nutri Zinc rice farmers have an elementary school education level. This means that there is a lack of awareness among farmers about the importance of education. Meanwhile, the level of education determines farmers in running their farming businesses such as the use of technology and marketing [43]. As many as 53.00% of farmers in Selopamioro have family members of 3–4 family members. In this study, Inpari Nutri Zinc rice farmers generally live with their wives and children, or with their wives and parents. Inpari Nutri Zinc rice farmers have relatively narrow land. The majority of farmers have land ranging from 100 to 1000 m^2. Land in Selopamioro Village tends to have a small land area. This is because the area in Selopamioro Village tends to be steep.

Kebonagung Village has the highest income because the age of farmers in Kebonagung Village is mostly still productive to work. The productive working age tends to get more income. The age of farmers has a positive influence on increasing farmer income, with a regression coefficient of farmer age of 0.002 [44]. The expenditure of Inpari Nutri Zinc rice farmers in Imogiri District is mostly IDR 0 –20,000,000. These household needs include food and non-food needs. If food expenditure is greater, the level of household welfare is classified as low. Many rice farmers who plant Inpari Nutri Zinc do not have food reserves. In **Table 2**, it can be seen that most of the land is rainfed land. This is due to the rain-fed irrigation system, so that rice can only be planted once a year. Food reserves in Kebonagung Village are higher because rice yields with irrigated land have a higher production level with an average food reserve of 871.27 kg [45].

4.2. Income and Expenditure

Based on **Table 3**, the highest income of Inpari Nutri Zinc rice farmers in Bantul Regency is from on-farm income, this is because the majority of farmers' family members also work in agriculture and some farmers also only focus on their own farming activities, in other words, they do not have side jobs. Kebonagung Village has the highest income, because most of the farmers there are of productive age. Farmers of productive age tend to earn higher incomes. The age of farmers has a positive effect on their income, with a regression coefficient of age of 0.002 [46].

Food and non-food expenditures must be balanced, the greater the non-food expenditure, the better the welfare. Based on **Table 4**, the largest food expenditure of farmers in Wukirsari Village is staple food needs, this is influenced by the number of family members. The greater the number of family members, the greater the consumption expenditure [47].

Based on **Table 4**, expenditure on clothing is very low, with some farmers reporting that they rarely buy clothes or only buy second-hand clothes, while others get clothes from their children. Although many farmers are elderly and require regular health check-ups, health spending remains low because they utilize the Healthy Indonesia Card, which is provided to poor people who cannot afford medical expenses.

Table 3. Analysis of household income of Inpari Nutri Zinc rice farmers in Bantul Regency.

Category	Selopamioro		Wukirsari		Kebonagung	
	IDR	%	IDR	%	IDR	%
Inpari Nutri Zinc rice	1,156,198.98	6.01	2,079,605.09	7.12	3,459,317.76	7.93
On farm	12,094,906.25	62.92	20,133,400.70	68.91	32,451,963.60	74.42
Off farm	3,947,187.50	20.53	4,892,957.75	16.75	6,000,000.00	13.76
Non farm	2,025,625.00	10.54	2,110,633.80	7.22	1,693,181.82	3.88
Total	**19,223,917.73**	**100.00**	**29,216,597.34**	**100.00**	**43,604,463.22**	**100.00**

Table 4. Household food and non-food expenditure of Inpari Nutri Zinc rice farmers in Bantul Regency.

Category	Selopamioro		Wukirsari		Kebonagung	
		%		%		%
Food Expenditure						
Staple Food	3,146,000	8.46	3,328,972	15.16	2,676,286	9.44
Side dishes	2,595,063	6.98	2,287,479	10.42	2,810,045	9.91
Vegetables	456,109	1.23	639,704	2.91	488,091	1.72
Seasonings	2,504,406	6.73	2,333,177	10.63	2,061,273	7.27
Fruits	792,938	2.13	888,254	4.05	584,909	2.06
Snacks	2,063,438	5.55	647,831	2.95	1,114,545	3.93
Cigarettes	2,148,500	5.78	1,230,042	5.60	1,313,864	4.63
Beverages	660,594	1.78	364,648	1.66	3,800,491	13.40
Total	**14,367,047**	**38.64**	**11,720,107**	**53.38**	**14,849,505**	**52.37**
Non-Food Expenditure						
Lighting and fuel	4,342,625	11.68	3,695,268	16.83	3,993,273	14.08
Taxes	400,813	1.08	383,127	1.74	600,955	2.12
Communication	1,380,000	3.71	1,041,915	4.75	458,364	1.62
Education	3,629,688	9.76	2,335,324	10.64	4,516,364	15.93
Daily necessities	1,015,500	2.73	410,423	1.87	392,455	1.38
Clothing	593,906	1.60	102,183	0.47	179,545	0.63
Healthcare	209,688	0.56	86,493	0.39	5,455	0.02
Social activities	11,247,000	30.25	2,181,634	9.94	3,356,727	11.84
Total	**22,819,219**	61.36	**10,236,366**	**46.62**	**13,503,136**	**47.63**
Total Expenditure	**37,186,266**	**100.00**	**21,956,473**	**100.00**	**28,352,641**	**100.00**

4.3. Welfare

Based on **Table 5**, the majority of Inpari Nutri Zinc rice farmers are classified as less prosperous because their expenditure on non-food needs is lower. The majority of farmers in Selopamioro are in the more prosperous category because their food needs are in the form of vegetables and fruits from their own harvest. In addition, it can also be influenced by the number of social activities such as donations for celebrations or deaths, meaning that the number of farmer relations causes large expenditures for social activities. Research in the Yogyakarta women's farming group on dry land shows that social expenditure is the second largest after lighting costs. Farmer welfare includes financial, social, health and environmental aspects [48, 49].

Table 5. Household welfare of Inpari Nutri Zinc rice farmers in Bantul Regency.

Welfare	Selopamioro		Wukirsari		Kebonagung		Total	
		%		%		%		%
Less prosperous	10	31.25	46	64.79	11	50.00	67	53.60
Prosperous	1	3.13	3	4.23	0	0.00	4	3.20
More prosperous	21	65.63	22	30.99	11	50.00	54	43.20
Total	**32**	**100.00**	**71**	**100.00**	**22**	**100.00**	**125**	**100.00**

4.4. HFIAS

Based on **Table 6**, most Inpari Nutri Zinc rice farmers are in the food secure category. Kebonagung Village has the highest percentage of food security. This is because food reserves in the form of rice are sufficient, as farmers in Kebonagung plant rice every planting season. On the other hand, 50% of farmers in Selopamioro Village are in the severe food insecure category, as their income is insufficient to meet their daily needs. As a result, some farmers only consume limited food and reduce expenses by relying on their own agricultural products.

Table 6. HFIAS category of Inpari Nutri Zinc rice farming households in Bantul Regency.

Category	Selopamioro		Wukirsari		Kebonagung	
	Σ	%	Σ	%	Σ	%
Food secure	12	37.50	42	59.15	17	77.27
Mild food insecurity	1	3.13	3	4.23	1	4.55
Moderate food insecurity	3	9.38	10	14.08	1	4.55
Severe food insecurity	16	50.00	16	22.54	3	13.64
Total	**32**	**100.00**	**71**	**100.00**	**22**	**100.00**

Based on the analysis in **Table 7**, it can be seen that the majority of answers are "no", indicating that most individuals are in a safe condition. The answer "yes", with a percentage exceeding 20%, is found in questions 4, 6, and 7. These questions are closely related to food availability. It can be concluded that some farmers may avoid consuming food or may eat less because they are bored or do not like the food available.

Table 7. HFIAS analysis on Inpari Nutri Zinc rice farming households in Bantul Regency.

Variabel	No		Yes						Total Yes	
			1–2x		3–10x		>10x			
	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%
Concern about food security (Q1)	101	80.80	7	5.60	6	4.80	11	8.80	24	19.20
Unable to eat preferred foods (Q2)	108	86.40	6	4.80	7	5.60	4	3.20	17	13.60
Consumption of only a few types of food (Q3)	101	80.80	13	10.40	8	6.40	3	2.40	24	19.20
Consumption of food that is not liked (Q4)	99	79.20	6	4.80	10	8.00	10	8.00	26	20.80
Eating in smaller portions (Q5)	102	81.60	15	12.00	5	4.00	3	2.40	23	18.40
The number of food servings is smaller (Q6)	99	79.20	12	9.60	7	5.60	7	5.60	26	20.80
No food at all (Q7)	96	76.80	12	9.60	9	7.20	8	6.40	29	23.20
Sleep while hungry (Q8)	102	81.60	7	5.60	9	7.20	7	5.60	23	18.40
Not eating for a whole day and night (Q9)	125	100.00	0	0.00	0	0.00	0	0.00	0	0.00

Based on **Table 8**, 56.80% of Inpari Nutri Zinc rice farming households are in the food secure category. The mild food insecurity category indicates families who are relatively able to meet their food needs, but food insecurity can arise due to poverty or natural disasters. Food insecurity occurs both at the household level and at the regional level [50]. The main cause of food insecurity is limited resources in poor communities; even though food is available in the market, farmers' incomes are not enough to buy it [51, 52].

Table 8. HFIAS category of Inpari Nutri Zinc rice farming households in Bantul Regency.

Category	Σ	%
Food secure	71	56.80
Mild food insecurity	5	4.00
Moderate food insecurity	14	11.20
Severe food insecurity	35	28.00
Total	**125**	**100.00**

Based on **Table 9**, farmers who are classified as food secure are generally between 60–68 years old, while farmers who are classified as food insecure are mostly in the age range of 69–77 years. Older farmers tend to experience food insecurity due to physical limitations. Advanced age can reduce a person's work productivity. However, the analysis of the age of the head of the family shows a significance value of 0.896, which is greater than 0.05, so the null hypothesis (H_0) is rejected. It can be concluded that the age of the head of the family does not have a significant effect on the food security of farming households in Bantul Regency [53].

Table 9. Age and food security.

Age (Year)	Food Secure		Mild Food Insecurity		Moderate Food Insecurity		Severe Food Insecurity	
	Σ	%	Σ	%	Σ	%	Σ	%
42–50	17	23.94	0	0.00	2	14.29	6	17.14
51–59	11	15.49	1	20.00	4	28.57	8	22.86
60–68	29	40.85	2	40.00	4	28.57	6	17.14
69–77	13	18.31	2	40.00	4	28.57	12	34.29
78–86	1	1.41	0	0.00	0	0.00	3	8.57
Total	**71**	**100.00**	**5**	**100.00**	**14**	**100.00**	**35**	**100.00**

Based on **Table 10**, the majority of farmers in each category are men, who generally have more freedom to work outside the home or manage farm businesses. Male farmers are also more often involved in physically demanding tasks with higher wages, such as plowing and digging. However, 10 out of 11 female farmers are included in the food security category, which may be due to women's ability to manage finances and farm activities effectively.

Based on **Table 11**, most farmers in the categories of food security, mild food insecurity, moderate food insecurity, and severe food insecurity have a final education level of elementary school. Farmers with a high level of education tend to be in the category of food security, this shows that education has an influence on food security. The results of the study in Sewon Village, Bantul also showed that the level of education of the head of the family had an influence on the food security status of farming households in Timbulharjo Village, Sewon District, Bantul [54].

Table 10. Gender and food security.

Gender	Food Secure		Mild Food Insecurity		Moderate Food Insecurity		Severe Food Insecurity	
	Σ	%	Σ	%	Σ	%	Σ	%
Male	61	85.92	5	100.00	14	100.00	34	97.14
Famale	10	14.08	0	0.00	0	0.00	1	2.86
Total	**71**	**100.00**	**5**	**100.00**	**14**	**100.00**	**35**	**100.00**

Table 11. Education and food security.

Educatian	Food Secure		Mild Food Insecurity		Moderate Food Insecurity		Severe Food Insecurity	
	Σ	%	Σ	%	Σ	%	Σ	%
No school	10	14.08	1	20.00	1	7.14	3	8.57
Elementary school	28	39.44	4	80.00	6	42.86	18	51.43
Junior high school	10	14.08	0	0.00	2	14.29	8	22.86
Senior high school	19	26.76	0	0.00	5	35.71	6	17.14
Higher education	4	5.63	0	0.00	0	0.00	0	0.00
Total	**71**	**100,00**	**5**	**100.00**	**14**	**100.00**	**35**	**100.00**

The number of family members is the number of members who are dependent on farmers to meet their living needs. Based on **Table 12**, farmers with 3–4 dependents tend to be food insecure, although in the food secure category, the majority of farmers also have 3–4 family members. This shows that the number of family members is not always directly correlated with food insecurity, because families with fewer members can also be in the food secure category [55].

Most of the Inpari Nutri Zinc rice farming households in Imogiri District, with 40% falling into the mild food insecurity category, have an income of IDR 0–20,000,000 (**Table 13**). This is in line with research showing that farmers with low incomes fall into the food insecurity category. However, this does not rule out the possibility that the higher the income level, the higher the food insecurity experienced. This is due to the limited diversity of food consumption patterns in rice farming households, with less varied food sources [56].

Table 12. Number of family members and food security.

Number of Family Members	Food Secure		Mild Food Insecurity		Moderate Food Insecurity		Severe Food Insecurity	
	Σ	%	Σ	%	Σ	%	Σ	%
1–2	31	43.66	0	0.00	5	35.71	12	34.29
3–4	34	47.89	5	100.00	4	28.57	15	42.86
5–6	6	8.45	0	0.00	5	35.71	5	14.29
7–8	0	0.00	0	0.00	0	0.00	3	8.57
Total	**71**	**100.00**	**5**	**100.00**	**14**	**100.00**	**35**	**100.00**

Table 13. Income and food security.

Income	Food Secure		Mild Food Insecurity		Moderate Food Insecurity		Severe Food Insecurity	
	Σ	%	Σ	%	Σ	%	Σ	%
IDR 0–20,000,000	12	16.90	2	40.00	1	7.14	5	14.29
IDR 20,000,001–40,000,000	9	12.68	0	0.00	1	7.14	5	14.29
IDR 40,000,001–60,000,000	9	12.68	1	20.00	2	14.29	5	14.29
IDR 60,000,001–80,000,000	4	5.63	1	20.00	2	14.29	4	11.43
IDR 80,000,001–100,000,000	3	4.23	1	20.00	2	14.29	3	8.57
IDR >100,000,000	34	47.89	0	0.00	6	42.86	13	37.14
Total	**71**	**100.00**	**5**	**100.00**	**14**	**100.00**	**35**	**100.00**

Based on **Table 14**, most of the rice farming households that are categorized as food secure have expenditures below IDR 40,000,001, which shows that the lower the expenditure, the higher the likelihood of food security in a household. However, some farmers with low expenditure are still classified as food insecure; this is due to low levels of education resulting in low skills in financial management. This is in line with research in Medan which found that family income, mother's education, number of family members, and provision of subsidized rice affect food expenditure, which is an indicator of food security [57, 58].

As seen in **Table 15**, 51.43% of farmers experiencing severe food insecurity are farmers with the smallest land area, ranging from 100 to 1000 m^2. Many Inpari Nutri Zinc rice farmers are concerned about the availability of food or resources in their households. This is undeniable, because farmers with smaller land areas tend to have lower incomes. In addition, the availability of food reserves from the harvest is sometimes not enough to meet the basic food needs of the farmer's household.

In **Table 16**, 69.01% of rainfed farmers are in the food secure category. This is due to the more varied planting patterns on rainfed land, so that farmers can plant crops other than rice that can be consumed according to the farmer's wishes or household needs. In addition, crops other than rice commodities can be sold at higher prices than rice. The diversity of food types also shows the quality and quantity of nutritious food in the household.

Table 14. Expenditure and food security.

Expenditure	Food Secure		Mild Food Insecurity		Moderate Food Insecurity		Severe Food Insecurity	
	Σ	%	Σ	%	Σ	%	Σ	%
IDR 0–20,000,000	33	46.48	3	60.00	3	21.43	11	31.43
IDR 20,000,001–40,000,000	33	46.48	2	40.00	5	35.71	12	34.29
IDR 40,000,001–60,000,000	3	4.23	0	0.00	4	28.57	7	20.00
IDR 60,000,001–80,000,000	2	2.82	0	0.00	2	14.29	3	8.57
IDR 80,000,001–100,000,000	0	0.00	0	0.00	0	0.00	2	5.71
Total	**71**	**100.00**	**5**	**100.00**	**14**	**100.00**	**35**	**100.00**

Table 15. Land area and food security.

Land Area (m^2)	Food Secure		Mild Food Insecurity		Moderate Food Insecurity		Severe Food Insecurity	
	Σ	%	Σ	%	Σ	%	Σ	%
100–1000	25	35.21	2	40.00	2	14.29	18	51.43
1001–2000	23	32.39	2	40.00	4	28.57	6	17.14
2001–3000	9	12.68	1	20.00	2	14.29	4	11.43
>3000	14	19.72	0	0.00	6	42.86	7	20.00
Total	**71**	**100.00**	**5**	**100.00**	**14**	**100.00**	**35**	**100.00**

Table 16. Land type and food security.

Land Type	Food Secure		Mild Food Insecurity		Moderate Food Insecurity		Severe Food Insecurity	
	Σ	%	Σ	%	Σ	%	Σ	%
Irrigation	22	30.99	2	40.00	7	50.00	23	65.71
Refers to rainfed	49	69.01	3	60.00	7	50.00	12	34.29
Total	**71**	**100.00**	**5**	**100.00**	**14**	**100.00**	**35**	**100.00**

In **Table 17**, the availability of food reserves increases farmers' food security, with food-insecure households usually lacking food reserves. Although farmers feel more secure with their harvest supplies, the results of the HFIAS instrument show that having large food reserves does not always guarantee food security, as external factors also contribute to food insecurity. The five factors that influence food insecurity are socio-economic conditions, climate, infrastructure, environment, and land productivity.

Table 17. Food reserves and food security.

Food Reserves	Food Secure		Mild Food Insecurity		Moderate Food Insecurity		Severe Food Insecurity	
	Σ	%	Σ	%	Σ	%	Σ	%
0	17	23.94	1	20.00	3	21.43	14	40.00
1–201	20	28.17	2	40.00	0	0.00	10	28.57
202–402	9	12.68	1	20.00	0	0.00	3	8.57
403–603	6	8.45	0	0.00	3	21.43	2	5.71
604–804	5	7.04	1	20.00	0	0.00	1	2.86
>804	14	19.72	0	0.00	8	57.14	5	14.29
Total	**71**	**100.00**	**5**	**100.00**	**14**	**100.00**	**35**	**100.00**

4.5. Energy Adequacy and Protein Adequacy

Ideally, the energy adequacy rate is 2,000 Kcal capita^{-1} day^{-1}, while the protein adequacy rate is 52 grams capita^{-1} day^{-1}. To see the achievement of energy and protein consumption according to the standard, you can compare the total actual Energy Adequacy Rate with 2,000 Kcal capita^{-1} day^{-1}, and the total actual Protein Adequacy Rate with 52 grams capita^{-1} day^{-1}. Based on the data in **Table 18**, it can be seen that the energy and protein adequacy rate exceeds the actual Energy Adequacy Rate and Protein Adequacy Rate, which have not met the standard.

Table 18. Average energy and protein consumption of Inpari Nutri Zinc rice farmer households in Bantul Regency.

Food Groups	Energy (Kkal capita^{-1})	Protein (gr capita^{-1})
Cereal grains	1,007.14	18.56
Tubers	2.61	0.04
Oily fruits and seeds	2.5	0.02
Oils and fats	90.27	0
Sugar	99.07	0
Protein-rich foods	261.37	17.37
Legumes	2.48	0.11
Vegetables and fruits	41.49	1.46
Total	**1,506.94**	**37.56**

The highest actual Energy Adequacy Rate comes from the rice food group. This is because rice is the staple food of the Indonesian population, and every household consumes rice products every day. Inpari Nutri Zinc rice farmers have the largest income from rice commodities, so it is very natural that the rice food group is rarely replaced by tubers.

4.6. Expected Food Pattern

Based on **Table 19**, the quality of food consumption of Inpari Nutri Zinc rice farmers is still far below the standard score of the Expected Food Pattern, which is 100, indicating low awareness of farmers in consuming food other than rice. This reflects the still limited knowledge of farmers about nutrition and balanced food needs. Research in rural areas also shows that the highest Expected Food Pattern score is obtained from grains, influenced by the lack of socialization about the importance of nutritional needs. As a result, rural communities' understanding of food and its nutritional content is still limited [59].

The average score of the Expected Food Pattern of Inpari Nutri Zinc rice farmer households is 63.23 with an average energy consumption of 1,506.94 kcal, still far from the standard energy requirement for adults, which is 2,000 kcal. Food groups that meet the standards are grains, oils & fats, and animal foods. Farming households consume more of these three types of food groups because they consume more oily or fried foods. Based on **Table 19**, Inpari Nutri Zinc rice farming households are included in the food insecure category because the Energy Adequacy Rate is less than 2,000 kcal capita^{-1} day^{-1}, the Protein Adequacy Rate is less than 52 grams capita^{-1} day^{-1}, and the Expected Food Pattern score is only 63.23, below the ideal Expected Food Pattern score of 100.

4.7. Factors Affecting Food Security (Logit Biner)

Based on **Table 20**, it is known that the significant value of 0.907 > alpha, then H_0 is accepted. This means that the model is FIT (appropriate); the model has been able to explain the data in accordance with other words the model is declared feasible or FIT to be used for further analysis.

Hypothesis:

H_0. *The model is FIT (p value > alpha), meaning the model adequately explains the data (FIT).*

H_a. *The model does not FIT, meaning the model does not explain the data well.*

Table 19. Analysis of household expected food patterns of Inpari Nutri Zinc rice farmers in Bantul Regency.

Food Groups	Proportion of Energy	Value	% Actual Energy Adequacy Rate	Skor Aktual	Skor Normatif
Cereal grains	50.36	0.5	25.18	25	25
Tubers	0.13	0.5	0.07	0.07	2.5
Oily fruits and seeds	0.12	0.5	0.06	0.06	5
Oils and fats	4.51	0.5	2.26	1	1
Sugar	4.95	0.5	2.48	2.48	2.5
Protein-rich foods	13.07	2	26.14	24	24
Legumes	0.12	2	0.25	0.25	10
Vegetables and fruits	2.07	5	10.37	10.37	30
Total	**75.35**	**11.5**	**66.80**	**63.23**	**100**

Table 20. G-Hosmer.

Step	Chi-Square	df	Sig.
1	3.395	8	0.907

The results of the analysis show a significance value of 0.001 <0.05, meaning that if household expenditure increases by 1 unit, the opportunity for increasing food security in Inpari Nutri Zinc rice farming households is 1-fold. Food security is related to food consumption in a household. In Wukirsari and Kebonagung Villages, food expenditure is more dominant (**Table 4**). However, this is different from research in Medan, where 88% of households fall into the food security category, with food consumption expenditure much lower than non-food expenditure. Education affects household food security. Based on **Table 21**, the significance value of the education variable is 0.009 < 0.05, which indicates that the higher the level of education, the higher the likelihood of the household being included in the food secure category. Inpari Nutri Zinc rice farmers with higher education are better able to manage their farmland and seek additional income outside of farming. The results of the regression analysis show that food availability and the average length of schooling for girls above 15 years have a significant effect on food security [61]. In addition, socio-demographic factors such as the age of the head of the household, level of education, and number of family members also have a significant influence on household food security [62, 63].

Gender variables also affect household food security in Inpari Nutri Zinc rice farmers, with a significance value of 0.094 > 0.1. The most prominent gender differences are in the field of work, where men can do more things than women due to limited energy and status in the household [64]. This study differs from the study in Gunung Kidul which found that gender did not affect food security in poor households, with a significance value of 0.568, which is greater than 0.05 [65].

Table 21. Factors affecting household food security of Inpari Nutri Zinc rice farmers in Bantul Regency.

Variabel	B	S.E	Wald	df	Sig.	Eksp (B)
X1 (Age)	–0.043	0.027	2.637	1	0.104	0.958
X2 (Number of family members)	–0.111	0.193	0.332	1	0.565	0.895
X3 (Total land area)	0.000	0.000	0.828	1	0.363	1.000
X4 (Income)	0.000	0.000	0.028	1	0.866	1.000
X5 (Expenditure)	0.000	0.000	11.620	1	0.001	1.000
X6 (Food reserves)	0.001	0.001	1.493	1	0.222	1.001
X7 (Education)	0.678	0.261	6.737	1	0.009	1.970
Dummy 1 (Gender)	1.882	1.123	2.807	1	0.094	6.565
Dummy 2 (Land type)	–0.683	0.534	1.637	1	0.201	0.505
Constant	2.928	2.139	1.872	1	0.171	18.681

5. Discussion

This study provides an overview of the development of Inpari Nutri Zinc rice varieties as an important step in agricultural innovation in Indonesia, with the aim of increasing food security and addressing malnutrition problems. Inpari Nutri Zinc rice has a high zinc content, a micronutrient that is very much needed for human health, especially to reduce stunting problems in children. This rice variety was issued by the Ministry of Agriculture in 2019 indicating an urgent need to increase the nutritional value of staple foods, one of which is in Bantul Regency.

1. Food Security and Stunting

The results of the study showed that 56.80% of Inpari Nutri Zinc rice farming households were categorized as food secure, while the rest faced varying levels of food insecurity. This condition is in accordance with the findings of the latest international study, which found that income and education factors have a significant influence on food security [66]. The high stunting rate in Imogiri District, which reached 434 children, strengthens the urgency of using this rice as a biofortification solution to overcome malnutrition [67].

2. Farmer Income and Expenditures

Tables 3 and **4** show that the income of farmers in Kebonagung Village is higher than in Selopamioro and Wukirsari. This is because the majority of farmers in Kebonagung are still in their productive age. The productive age of farmers has a positive relationship with income. However, food expenditure in Wukirsari is higher compared to other villages, which indicates a dependence on staple foods. High food expenditure indicates a lower level of welfare [68].

3. Socio-Economic Factors Affecting Food Security

Binary logit analysis shows that education, household expenditure, and gender variables have a significant effect on food security. The education of the head of the household plays an important role in improving food security. In addition, gender also plays a significant role, where male farmers are more involved in physical agricultural activities than women, who focus more on household management. The effect of gender on food security can vary depending on the local socio-economic context [69].

4. Nutritional Adequacy Figures and Expected Food Patterns

The average energy consumption of farmer households is 1,506.94 kcal capita^{-1} day^{-1}, which is still far below the standard of 2,000 kcal capita^{-1} day^{-1}. The Nutritional Adequacy Figure of farmer households often does not meet the nutritional needs standard. In addition, the Expected Food Pattern (PPH) score of 63.23 also indicates a lack of diversity in food consumption. The low diversity of food consumption is often caused by a lack of knowledge about nutrition and limited access to nutritious food [70].

5. Challenges and Solutions

Although the Inpari Nutri Zinc rice variety shows significant potential to improve food security and reduce stunting, socio-economic challenges such as low income and education levels of farmers are major obstacles. As a solution, a comprehensive policy is needed that includes increasing access to education, diversifying income sources, and providing education on healthier food consumption patterns.

In general, this study follows previous studies related to food security which is influenced by socio-economic factors and the availability of food reserves. However, this study provides additional contributions by highlighting the role of increasing nutritional value through Inpari Nutri Zinc rice in improving the nutritional quality of the community. This reinforces the importance of agricultural innovation in supporting national food security [71].

6. Conclusions

This study shows that the Inpari Nutri Zinc rice variety has great potential in improving food security and the nutritional quality of the community, especially in areas with high stunting rates such as Bantul Regency. Most farming households still face socio-economic challenges, such as low income, limited access to education, and less diverse food consumption patterns. Factors

such as household expenditure, education of the head of the family, and gender play an important role in determining the level of food security.

The authors provide suggestions to stakeholders, especially the Indonesian Ministry of Agriculture, in expanding the distribution and access of Inpari Nutri Zinc rice seeds to other stunting-prone areas, as well as providing training to farmers on more productive and efficient agricultural practices. Local governments should also develop nutrition education and food diversification programs, especially in areas with high stunting rates. In addition, further research should also be conducted to measure the long-term impact of the use of Inpari Nutri Zinc rice on community food and nutrition security.

Author Contributions

Conceptualization, L.R., F.K., Z.R., C.W.R.; methodology, L.R., F.K.; formal analysis, F.K.; investigation, L.R., F.K.; writing—original draft preparation, F.K., L.R.; writing—review and editing, F.K., L.R., Z.R.; supervision, L.R., Z.R.; project administration, F.K.; funding acquisition, F.K. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Research and Innovation Institute, Universitas Muhammadiyah Yogyakarta (Letter No: 963/D.2-VIII/LRI/XII/2024 on 1 July 2024).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data supporting the findings of this study are available upon reasonable request to the corresponding author. This includes anonymized data to ensure the confidentiality of participants, such as farmers, traders, and consumers. The available data comprise interview results, survey responses, and statistical analyses utilized in this study. However, raw data such as personal information or identifiable data of participants are not publicly accessible due to privacy and ethical considerations. Any requests for data access will be evaluated based on the purpose of the data use and its alignment with the consent provided by participants.

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Conflicts of Interest

The authors declare no conflict of interest.

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