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Study of income and food consumption expenditure households of wet-rice farmers in West Sumatra, Indonesia

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ABSTRACT
This study aims to analyze socio-economic factors affecting the per capita income of households of wet-rice farmers, socio-economic factors affecting food consumption expenditure of these households, and to calculate income elasticity. The study employs a quantitative design, utilizing a multistage sampling method to determine the sample. The total sample size consisted of 349 farmer households. Data were analyzed using Two-Stage Least Squares regression. Based on the analysis, the following findings were obtained: 1) Variables such as food consumption expenditure, technical efficiency, off-farm work, diversification in agriculture, land tenure status, access to credit, and education have a positive and significant influence on the per capita income of farm households. 2) Variables including per capita income, access to credit, age, location, marital status, and education have a positive and significant influence on the per capita food consumption expenditure of farmer households. 3) Income elasticity for all quantiles has a value of E<1, indicating the applicability of Engel's law. This study provides comprehensive insights into the economic behavior of paddy field farming households by examining both the determinants of household income and food consumption expenditure. It also discusses policy implications for food availability, food consumption quality, food diversity, and poverty alleviation policies.

Contribution/Originality: Analysis of income and per capita food consumption expenditure of households of wet-rice farmers using TSLS. The originality of this study is to use the estimated household food consumption expenditure variable as one of the determinants of household income. Food consumption expenditure has a positive regression coefficient and is significant for the per capita income of farming households.

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1. INTRODUCTION
In Indonesia, 35.10 percent of households are engaged in the agricultural sector (Center for Agricultural Data and Information Systems, 2022). This data indicates that the agriculture sector plays a crucial role as a source of income and employment opportunities for the Indonesian population, especially in rural areas. However, the

agricultural sector has a high poverty rate, with nearly one-fifth of farming households living in poverty (FAO, 2018). The highest proportion of poor people (62.66 percent) is found in the food crop subsector (Center for Agricultural Data and Information Systems, 2022). The food crop most widely cultivated by rural households is rice. Rice cultivation occurs in 34 provinces across Indonesia, including West Sumatra. Rice is a key commodity for national food self-sufficiency.

The welfare of wet-rice farming households can be measured, among other things, using indicators such as household income and expenditure. Household income refers to the total gross income earned by all members of the household labor force (Islam, Islam, Fatema, & Khanum, 2022). Previous researchers, Emran, Krupnik, Aravindakshan, Kumar, and Pittelkow (2021) found that rice farming households engage in a variety of activities including agricultural work as well as non-farm activities to increase household income. This finding indicates that, in general, rice farming households have diversified income sources. Income diversification is carried out to maintain income stability in the face of productivity problems, climate change, food insecurity, and poverty (Getahun, Haji, Mehare, & Zemedu, 2023).

Farmer household income can be used for consumption and non-consumption expenditures, such as savings. Consumption expenditure can be categorized into non-food consumption and food consumption expenditure (Central Bureau of Statistics, 2023). Food is a key determinant of the welfare dimension; therefore, food expenditure is a fundamental component in any analysis of poverty and food security. Food consumption expenditure is related to the Sustainable Development Goals (SDGs) target to eliminate hunger and all forms of malnutrition by 2030 (FAO, 2018).

Previous researchers have analyzed the determinants of household food consumption expenditure, such as; Ramdhanie, Pemberton, and Granderson (2017) and Salo, Savolainen, Karhinen, and Nissinen (2021) using the Ordinary Least Square (OLS) regression estimation model. The main finding of the aforementioned studies is that the income variable is a positive and significant determinant of household food consumption expenditure. However, the use of OLS regression estimation may cause bias problems because the income variable is also endogenous.

Rashid, Sesabo, Lihawa, and Mkuna (2024) have used a simultaneous equation model to analyze the interacting relationship between income and expenditure. Based on the SEM analysis model, it was found that the income variable has a positive and significant influence on household food consumption. This finding indicates that food consumed by households is a normal good. Mulamba (2022) has also found that the absolute amount of food expenditure increases as household income increases. Both findings above indicate that the food consumed by households is quality food. Consumption of quality food affects health (Petrescu, Vermeir, & Petrescu-Mag, 2020). Health can have a direct impact on income (Xie, Huang, & Zang, 2020). About the findings above, the gap in this research is that no research has been found that estimates the variable of food consumption expenditure on household income. Thus, the originality of this research lies in the estimation of food consumption expenditure as one of the determinants of household income among rice farmers. This study aims to analyze (1) the socio-economic factors affecting the per capita income of wet-rice farming households, (2) the socio-economic factors influencing their food consumption expenditure, and (3) the income elasticity across five quantile groups (10%, 25%, 50%, 75%, and 90%) to examine the applicability of Engel's Law. The structure of this paper includes the introduction, methods, results, discussion, conclusion, and recommendations.

2. LITERATURE REVIEW

According to Engel's law, there is a negative relationship between income and the proportion of household expenditure allocated to food. Researchers have found the suitability of Engels' law in the relationship between household income and the proportion of food expenditure. Kostakis, Paparas, Saiti, and Papadaki (2020) found that the share of food consumption expenditure increases in an inverse U-shaped relationship with the amount of income. Lower-income households allocate a larger proportion of their income to food consumption expenditure. When income begins to increase, the allocation shifts towards non-food consumption expenditure.

Previous researchers such as Salo et al. (2021), Htar et al. (2022), and Tesgera, Beyene, and Wakjira (2024) found that income has a positive and significant influence on food consumption expenditure. This indicates that as income increases, food consumption expenditure also increases. Based on these findings, an increase in average household income can be used to improve food quality. In this regard, Ferrier and Zhen (2017) found that in the top three income quintiles, there was a greater income elasticity for quality food compared to the bottom two income quintiles. The study by Manyullei and Arundhana (2021) found that the behavior of low-income households is to spend a larger proportion of their expenditure on food without regard to quality, indicating that food quality is not a priority for low-income households Ferrier and Zhen (2017)

Rice farming income plays an important role in farmers' household income. Previous research found that the contribution of rice farming income to household income was 49.29 per cent (Karmini & Karyati, 2018). Researchers Danso-Abbeam, Dagunga, and Ehiakpor (2020) found that efficient use of resources in agriculture can generate higher income. This indicates that technical efficiency has an important role in the achievement of income in agriculture. Wang, Xu, Li, Zhuo, and Zou (2023) argued that improving the efficiency of agricultural production can reduce production costs so that it will increase income in agriculture.

Researcher Obayelu, Obayelu, and Tunrayo Awoku (2022) found that farming households that practiced one branch of farming were always poor. This indicates that other sources of income are needed. Diversification in crop farming improves farmers' welfare due to increased productivity and net income from farming (Baiyegunhi, Akinbosoye, & Bello, 2022). Diversification affects differentiation and increases income (Kurdyś-Kujawska, Strzelecka, & Zawadzka, 2021). Karmini and Karyati (2018) found that rice farmers' income sources consist of income from rice farming and non-rice income. The positive and significant impact of crop diversification on farm income is approximately 13 percent (Basantaray, Acharya, & Patra, 2024).

Income from agriculture is insufficient to meet the needs of rural households (Olugbire et al., 2020). Off-farm employment is a strategy for household income stability in the face of risks in agriculture. Non-farm work plays an important role in increasing the income and welfare of farming households (Bjornlund et al., 2019; Damilola & Ogundeji, 2023).

Land tenure security is a key factor in poverty reduction (Ekpodessi & Nakamura, 2022). Owned land generates higher incomes than rented and shared land (Rondhi & Adi, 2018). Land thus has a positive impact on household income (Sultana, Mahmud, Moniruzzaman, & Tareque, 2024).

Education has a positive effect on household income (Vu, Ho, & Le, 2020). This indicates that the higher the level of formal education, the higher the household income. Hoang (2021) found that farmer household heads with higher formal education invested more in agricultural technology resulting in higher farm income.

The effect of the age variable on income in agriculture differs among researchers; Vu et al. (2020) and Ferrer et al. (2022) found that the age of the household head has a positive and significant effect on income in agriculture.

Gender has a positive influence on farm household income (Rashid et al., 2024). Gender has a positive and insignificant influence on farm household income (Siaw et al., 2023). The above findings show that the effect of gender on farm household income can be either positive or negative, depending on the conditions present in the research area.

The following presents a literature review of the influence of socio-economic variables (such as credit access, education, age, gender, location, and marital status) on food consumption expenditure. One aspect of financial development is credit. Access to formal credit plays a significant role in increasing monthly per capita farm household expenditure (Dimova & Adebowale, 2018; Kumar, Mishra, Saroj, & Joshi, 2017).

Factors that have a positive and significant influence on protein food expenditure are the wife's education level (Lasitya, Anindita, & Syafrial, 2022). In contrast to the findings of the above researcher Tingum and Kuponiyi (2020) found that education has a negative and significant influence on food expenditure. The above findings indicate that the effect of household head education on food consumption expenditure may vary due to the intervening role of the mother in determining family nutrition.

The age of the household head has a positive influence on food expenditure (Rashid et al., 2024). The age of adults and children has a positive and significant influence on food expenditure. In general, food expenditure of younger households tends to increase less than that of the reference group (age 45-54). However, service expenditure is higher in younger households, which can partly be attributed to higher consumption of service restaurants (Salo et al., 2021). Gender disparities affect food security and nutrition (FAO, 2019). Gender plays a role in household consumption decisions (Quisumbing & Doss, 2021). Gender plays a role in food purchases (Acharya, 2021). Gender has a positive influence on food expenditure (Rashid et al., 2024; Tingum & Kuponiyi, 2020).

Rural and urban locations cause differences in household food consumption patterns. Food expenditure elasticity is higher in rural areas than in urban areas (Rashid et al., 2024). An increase in income has been shown to increase food expenditure. The effect of changes in income on the consumption structure of urban residents is that the portion of staple foods has decreased, while the percentage of nutritious foods has increased (Jovanovic, 2016). Marital status has a negative influence on food consumption expenditure (Adzawla & Kudadze, 2017). However, Kostakis et al. (2020) found that marital status has a positive influence on per capita food consumption. Thus, the effect of marital status on food consumption expenditure can have a positive or negative coefficient.

3. METHODOLOGY

The study was located in West Sumatra province. The population in the study was all households of wet-rice farmers located in 19 districts and cities. Sampling using a multistage sampling technique. The first stage of determining the sample districts and cities using the formula fi = n / M, where fi is the sample fraction, n = number of samples, M = number of primary sampling units (PSU). The sample fraction is 42.10 per cent or with the formula fi = 8/19 x 100 per cent = 42.10 per cent. Sampling was done randomly. The selected cities and districts are: Padang City, Bukittinggi, Payakumbuh, Agam Regency, Padang Pariaman, Pesisir Selatan, Tanah Datar and Solok. The second stage, the determination of the sample sub-districts considering access to locations near and far from the center of the input and output market of paddy rice, purposive sampling, totaling 16 sub-districts namely: (1) Koto Tangah, (2). Kuranji (3), Aur Birugo and Tigobaleh. (4) Mandiangi koto Selayan (5). Payakumbuh Utara (6) Payakumbuh Barat (7). Lubuk Basung (8) Ampek Angkek (9). IV jurai (10). XI Koto Tarusan (11). Lubuk Alung (12). Padang Sago (13). Pantai Cermin (14). Kubung (15). Rambatan. (16) Salimpaung.

In the third stage, determining the number of samples of rice paddy farmer households using the Isaac and Michael table with α = 5 per cent, the number of samples was 349 farmer household heads. Sampling using the purposive sampling method, namely landowner and non-landowner farmers. Data collection method using questionnaires in May to July 2023. The total number of questionnaires was 349. Data analysis uses the Two-Stage Least Square (TSLS) simultaneous equation model. The use of 2 SLS in the study because there is a possibility of endogeneity in the income and food consumption expenditure variables so that the OLS estimate becomes biased. Using 2 SLS provides consistent and reliable parameter estimates. The difference between this researcher and previous studies lies in the food consumption expenditure variable as a determinant of the income variable, while in previous studies the food expenditure variable was not used as a determinant of income.

The conceptual framework used in this study is presented in Figure 1. In Figure 1, there are two endogenous variables, namely household income per capita (Y1) and food consumption expenditure per capita (Y2). The Y2 variable will function as an exogenous variable in the household income equation. Conversely, variable Y1 can function as an exogenous variable in the household food consumption expenditure equation. Based on the literature review, 1) the household income variable is influenced by variables such as technical efficiency, agricultural diversification, off-farm work, land tenure status, credit access, education, age, gender, and food consumption

expenditure. 2) The food consumption expenditure variable is influenced by household income, credit access, education, age, gender, rural/urban location, and marital status. Based on the conceptual framework above, the data are analyzed using 2SLS.

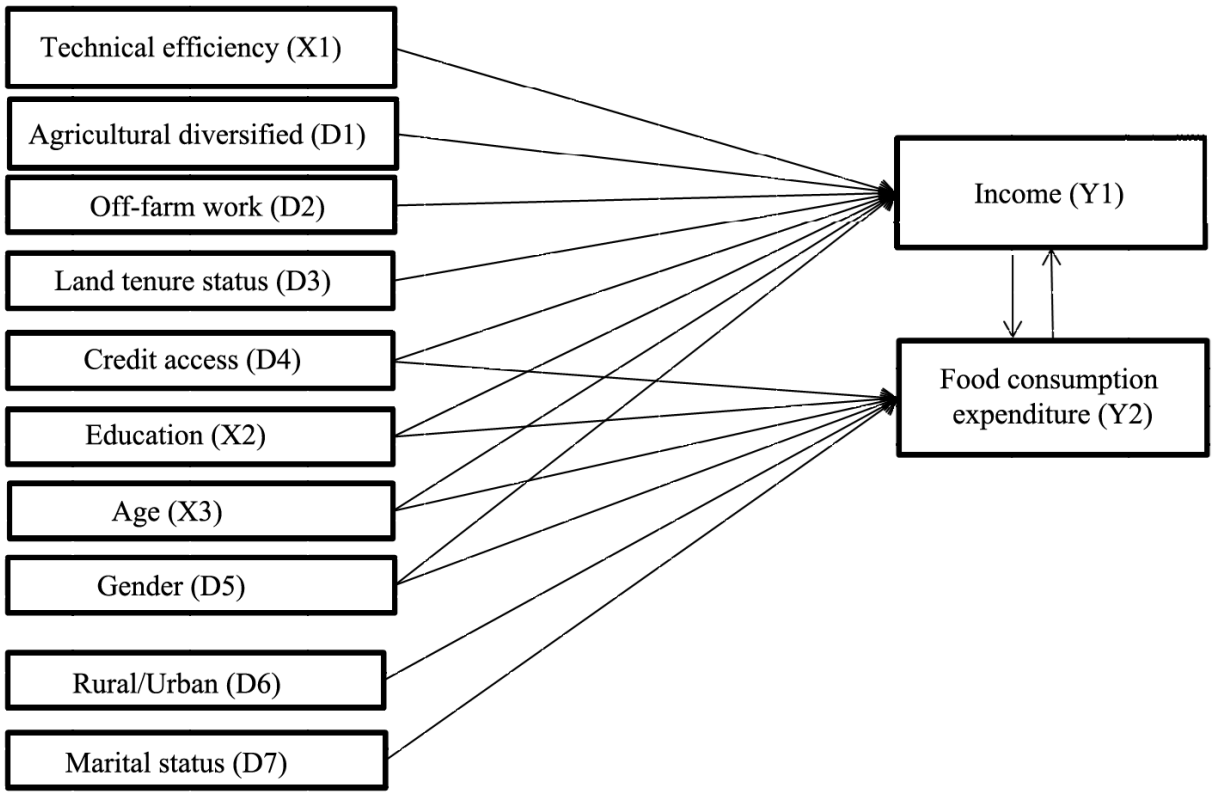

Figure 1. Conceptual framework.

Equation of household income (1) and household consumption expenditure (2).

$$\ln Y_1 = \alpha_0 + \alpha_1 Y_2 + \alpha_2 X_1 + \alpha_3 X_2 + \alpha_4 X_3 + \alpha_5 D_1 + \alpha_6 D_2 + \alpha_7 D_3 + \alpha_8 D_4 + \alpha_9 D_5 + e_1 \quad (1)$$

$$\ln Y_2 = \beta_0 + \beta_1 \ln Y_1 + \beta_2 \times_2 + \beta_3 \times_3 + \beta_4 D_4 + \beta_5 D_5 + \beta_6 D_6 + \beta_7 D_7 + e_2 \quad (2)$$

The operational definitions of the above variables can be seen in Table 2. The structural model is presented in Equation 3 and 4.

$$\ln Y_1 = \alpha_0 + \alpha_1 \hat{Y}_2 + \alpha_2 \times_1 + \alpha_3 \times_2 + \alpha_4 \times_3 + \alpha_5 D_1 + \alpha_6 D_2 + \alpha_7 D_3 + \alpha_8 D_4 + \alpha_9 D_5 + e_{1^*} \quad (3)$$

$$\ln Y_2 = \beta_0 + \beta_1 \ln \hat{Y}_1 + \beta_2 \times_2 + \beta_3 \times_3 + \beta_4 D_4 + \beta_5 D_5 + \beta_6 D_6 + \beta_7 D_7 + e_{1^*} \quad (4)$$

Where α_0 and β_0 are constants, while αi and βi are regression coefficients and e - error term. Identification test, for Equation 3 and 4 K-k > m - 1 or over identified. The results of the Hausman Test on the equation model of farm household per capita income (Y1) and food consumption expenditure Y2 Table 1 shows that both equations can be estimated using the TSLS method where α_0 and β_0 are constants, while αi and βi are regression coefficients and e - error term. Identification test, for Equation 3 and 4 K-k > m - 1 or over identified. The results of the Hausman Test on the equation model of farm household per capita income (Y1) and food consumption expenditure Y2 Table 1, show that both equations can be estimated using the TSLS method.

Table 1. Hausman test results.

Equation	*F-test*	Probability	Description
Y_1	29.188	0.000 ***	Simultaneous
Y_2	22.601	0.000 ***	Simultaneous

Note: ***p <0.01.

4. RESULTS AND DISCUSSIONS

The results of descriptive statistics are presented in Table 2. The total income per capita of farmer households amounted to Rp1,726,511 per month, and food consumption expenditure per capita per month was Rp750,880. The proportion of food consumption expenditure to per capita income was 43.49 percent. The technical efficiency of paddy rice farming was 89.22 percent, indicating that efficiency could still be improved by 10.78 percent. Farmer households with income sources from non-farm work comprised 67 percent, while 33 percent did not have access to non-farm work. The number of farmer households involved in diversification activities on farms was 46.10 percent, suggesting that most (53.90 percent) do not have access to diversification activities on farms.

Table 2. Descriptive statistics of research variables.

Variable	Description	Mean	Std. dev.	Min.	Max.
lnY_1	Per capita income (IDR) per month	1,726.511	1,010.658	280.387	6,992.864
lnY_2	Food consumption expenditure per capita (IDR) per month	750.880	348.995	303.088	2,718.360
X_1	Technical efficiency	89.22	7.50	56.00	97.00
D_2	Off-farm work (Yes = 1, No =0)	0.67	0.47	0.00	1.00
D_1	Agricultural diversified (Yes = 1, No =0)	0.46	0.50	0.00	1.00
D_3	Land tenure status (Owner = 1, No = 0)	0.52	0.50	0.00	1.00
D_4	Credit access (Yes = 1, No =0)	0.46	0.50	0.00	1.00
X_2	Education (Year)	10.09	2.67	6.00	16.00
X_3	Age (Year)	49.23	8.52	22.00	70.00
D_5	Gender (Male = 1, Female =0)	0.89	0.32	0.00	1.00
D_6	Desa/Kota (Rural = 1, Urban =0)	0.69	0.46	0.00	1.00
D_7	Marital status (Married =1, No=0)	0.78	0.42	0.00	1.00

The land tenure status variable has an average value of 0.52, indicating that 52 percent of farmer household heads are landowners, and 48 percent are sharecroppers. Access to credit has an average value of 0.46, meaning that approximately 45.80 percent of farmer households access formal credit, while 54.20 percent do not. The average education level of farmer household heads is 10.07 years, which suggests that the average household head has completed junior high school. The average age of farmer household heads is 49.23 years, indicating they are within the productive age range.

Gender has an average value of 88.50 percent, indicating that 88.50 percent of farmer households are headed by men, while 11.50 percent are headed by women. The rural or urban location has an average of 0.688, suggesting that most (68.80 percent) of farmer households reside in rural areas, with a smaller proportion (31.20 percent) residing in urban areas. Marital status has an average value of 0.779, meaning that 77.90 percent of farmer household heads are married, and 21.10 percent are not married.

Table 3 presents the socio-economic characteristics based on household income groups. Based on land tenure status, the number of sharecropper households in the low-income group is 40.12%, in the middle-income group is 46.18%, and in the high-income group is 13.77%. This finding indicates that farmer households are larger in the middle-income group. In contrast, landowners are more likely to be in the high-income group at 31.32% and in the middle-income group at 55.40%, compared to 13.19% in the low-income group. Land ownership is associated with increased income. Among farmer households with credit access, the middle-income group has the highest credit access at 48.77%, while the low-income group with no credit access is 52.94%. Credit access is more utilized by the middle- and higher-income groups, who may have a better capacity for loan repayment.

Table 3. Socio-economic characteristics by household income group.

Variable	Low income (%)	Middle income (%)	High income (%)
Land tenure status			
Profit sharing	40.12	46.18	13.77
Owner	13.19	55.40	31.32
Access to credit			
No credit access	31.10	52.94	16.04
Credit	20.37	48.77	30.86
Education			
Elementary school	50.00	40.00	25.00
Junior high school	37.50	50.00	12.50
Senior high school	21.05	57.89	21.05
Associate degree	15.09	56.60	28.30
Bachelor's degree	11.27	46.48	42.25
Age (Year)			
22 - 30	50.00	40.00	25.00
31 - 40	37.50	50.00	12.50
41 - 50	21.05	57.89	21.05
51 - 60	15.09	56.60	28.30
61 - 67	11.27	46.48	42.25
Gender			

Variable	Low income (%)	Middle income (%)	High income (%)
Male	20.73	50.78	28.50
Female	53.14	49.38	15.43
Rural/Urban			
Rural	32.79	51.91	15.30
Urban	18.67	50.00	31.33
Marital status			
Unmarried	28.46	55.28	16.26
Married	24.78	48.67	26.55

Based on formal education, it can be observed that households with higher income levels tend to have a greater percentage of individuals with higher education, particularly at the undergraduate level, accounting for 42.25%. Low-income households are predominantly composed of elementary school graduates, representing 50.00%. Middle-income households include individuals with junior high school education at 50.99%, high school education at 57.89%, and diploma holders at 56.60%, with junior high school graduates constituting 8.60%. Higher levels of education are generally associated with higher income levels. Regarding age characteristics, farmer households in the middle-income group have the highest proportions across all age groups. Middle-income households are more concentrated in the productive age range of 31-50 years. The age group of 31-50 years plays a significant role in income generation, while the younger age group of 22-30 years tends to fall into the lower income category.

Based on gender, males and females dominate the middle-income category, accounting for 50.78% and 31.49%, respectively. The middle-income group is also more male-dominated at 28.08%, suggesting that females may have greater opportunities for empowerment. In terms of rural and urban locations, the number of urban residents in the high-income group is relatively high at 31.33%, compared to 15.30% of the rural population. Most rural and urban farmer households are in the middle-income group.

Marital status indicates that unmarried individuals are more prevalent in the middle-income group at 55.28%, compared to 48.67% for married individuals. In the high-income group, the percentage of married households exceeds that of unmarried households. This finding suggests that marital status may be related to economic stability, with married individuals tending to have higher incomes.

Table 4 presents the regression estimation results using Multiple Linear Regression (OLS) and TSLS of the farmer household income equation. From the estimation results, it can be seen that there is a difference in the value of the regression coefficient and the value of R2. R2 value of the OLS estimation results is higher than TSLS. In Table 4, the estimation using OLS obtained an R^2 value of 87.68% (high), but may contain bias due to endogeneity. While the TSLS estimation produces an R^2 value of 43.88% or lower but TSLS is more valid in overcoming endogeneity based on the Hausman Test, so TSLS is more appropriate to use because there may be endogeneity in the OLS model. Below is a description of the regression estimation results using TSLS of farm household income.

The food consumption expenditure variable has a regression coefficient of 0.375. This result indicates that an increase in food consumption expenditure per capita by one percent will increase household income per capita by 0.38 percent, assuming ceteris paribus. The next variable with a positive coefficient on per capita income of farmer households is the technical efficiency of paddy rice farming, which is 0.016. This figure indicates that an increase in technical efficiency by one percent increases the income of farm households by 0.02 percent.

Activities related to diversification in agriculture have a regression coefficient of 0.156 concerning the per capita income of farmer households. The results of this study suggest that a one-unit increase in the number of farm households diversifying into agriculture will increase per capita income by 0.16 percent, assuming all other factors remain constant. The off-farm work activity variable has a regression coefficient of 0.325 concerning the per capita income of farm households. This indicates that an increase in off-farm work activity by one unit will raise farm household income by 0.33 percent, assuming other factors remain unchanged.

The regression coefficient for the land tenure status variable is 0.357 concerning the income per capita of farmer households. This indicates that if the number of landowners increases by one unit, the household income per capita will increase by approximately 0.36 percent, assuming other factors remain constant. The regression coefficient for access to credit is 0.09. This suggests that an increase in access to formal credit by one unit will raise the income per capita of farmer households by approximately 0.09 percent.

Education has a positive effect of 0.03 on the per capita income of farmer households. This finding indicates that an increase in the education level of the head of a farmer household by one year will increase the household's per capita income by 0.03 percent, assuming other variables remain constant. Age has a negative effect of 0.01 on household per capita income. This suggests that a one-year increase in the age of the farmer household head will lead to a 0.01 percent decrease in the household's per capita income, assuming other variables are constant. Similar to age, the gender variable also has a negative regression coefficient of 0.18. This indicates that female-headed households have higher per capita incomes than others. The R-squared value from the TSLS regression estimation results is 0.4388, meaning that the socio-economic variables included in the model explain 43.88 percent of the variation, while the remaining 56.12 percent is determined by other variables not included in the model.

Table 4. OLS and TSLS estimation results of farmer household income (Y_1).

Variable	OLS			TSLS		
	Coefficient	t-statistic	Prob.	Coefficient	t-statistic	Prob.
$\ln Y_2$	0.35	6.51	0.00***	0.38	6.16	0.00***
X_1	0.002	16.29	0.00***	0.02	4.96	0.00***
D_1	0.05	20.41	0.00***	0.33	6.18	0.00***
D_2	0.02	10.00	0.00***	0.16	3.34	0.00***
D_3	0.04	19.04	0.00***	0.36	6.98	0.00***
D_4	0.01	5.55	0.00***	0.09	1.91	0.06*
X_2	0.004	8.90	0.00***	0.03	2.85	0.01***
X_3	-0.001	-4.61	0.00***	-0.01	-1.73	0.08*
D_5	-0.02	-6.50	0.00***	-0.18	-2.26	0.02**
Constant	1.070	11.63	0.00***	3.01	6.58	0.00***
R^2	0.877			0.439		
F-test	268.17					
Probability	0.00			0.00		
Normality				0.92		
Hausman test				29.45		
Heteroskedasticity				0.26		
N	349			349		

Note: ***p <0.01, **p <0.05 and *p<0. 10.

The results of the OLS and TSLS regression estimation of the farm household consumption expenditure equation (Table 5). From the estimation results, it can be seen that there are differences in the regression coefficient values and R2 values of the two models, namely the R2 value of the OLS estimation results is higher than TSLS. In Table 5, the estimation using OLS obtained an R^2 value of 74.4% (high), but may contain bias due to endogeneity. While the TSLS estimation produces an R^2 value of 21.2% or lower but TSLS is more valid in overcoming endogeneity based on the Hausman Test, so TSLS is more appropriate to use because there may be endogeneity in the OLS model. The following is a description of the results of the TSLS regression estimation of farm household consumption expenditure. Household income has a regression coefficient of 0.23. This indicates that a one percent increase in per capita income will increase per capita food consumption expenditure of farm households by 0.23 percent, assuming other factors remain unchanged. The positive effect of income on food consumption expenditure indicates that households consume normal or quality food products. Credit access has a regression coefficient of 0.13. This finding means that an increase in credit access by one unit will increase per capita food consumption expenditure of farm households by 0.13 percent, assuming ceteris paribus. Age has a positive effect of 0.08 on per capita food consumption expenditure of farm households. The results of this study indicate that increasing the age of the household head by one year will increase food consumption expenditure by 0.08 percent, assuming ceteris paribus. Gender has a negative coefficient of 0.15 on per capita food consumption expenditure of farm households. This finding indicates that households headed by women have greater food consumption expenditure than other households, assuming other factors remain unchanged. The rural or urban location variable has a regression coefficient of 0.094. This finding indicates that the proportion of food consumption expenditure in rural areas is higher than in urban areas. The variable marital status has a regression coefficient of 0.10, indicating that an increase in the number of married farming households by one unit will increase per capita food consumption expenditure by 0.10 percent, assuming other factors remain constant. Education has a regression coefficient of 0.01. This coefficient suggests that an additional year of education for the head of a farming household will increase per capita food consumption expenditure by 0.01 percent. In other words, the higher the education level of the household head, the higher the per capita food consumption expenditure, assuming other factors remain unchanged.

Table 5. OLS and TSLS estimation results of food consumption expenditure (Y_2).

Variable	OLS			TSLS		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
$\ln Y_1$	0.24	13.49	***	0.23	5.98	***
D_4	0.02	12.44	***	0.13	3.14	***
X_2	0.002	5.75	***	0.01	1.67	*
X_3	0.01	16.32	***	0.08	3.96	***
D_5	-0.03	-9.20	***	-0.15	-1.97	**
D_6	0.01	5.91	***	0.09	2.18	**
D_7	0.02	9.54	***	0.10	1.66	*
Constant	1.33	40.04	***	4.41	16.31	***
R^2	0.744			0.212		
F-test	141.23					
Probability	0.000			0.000		
Hausman test				13.072		
Normality Test				0.306		
Heteroscedasticity test				0.267		
N	349			349		

Note: ***p <0.01, **p <0.05 and *p<0. 10.

Table 6 presents the quantile regression estimates for the food consumption expenditure equation. The income elasticity values (E) across the five quantile groups (10%, 25%, 50%, 75%, and 90%) show values of E < 1, indicating the applicability of Engel's law in this study. All regression coefficients are positive and significant at the 1 per cent level.

Table 6. Quantile regression estimation of food consumption expenditure.

Quantile	10%	25%	50%	75%	90%
Income	0.551***	0.552***	0.562***	0.457***	0.372***

Note: ***p <0.01.

In Table 6, it can be observed that the income of farm households in the bottom 10% quantile shows that every one percent increase in income significantly raises food expenditure by 0.551 percent. This suggests that poor households tend to allocate a higher proportion of their income to food expenditure. Households in the 25% quantile income group have an almost identical elasticity to the 10% quantile, which is 0.552. This indicates that a one percent increase in income will significantly raise food expenditure by 0.552 percent. Therefore, in this group, an increase in income also has a strong effect on food consumption. In the median 50% quantile, the effect of income on food consumption is 0.562, which is higher than in the lower quantile. This coefficient indicates that a one percent increase in income will significantly raise food expenditure by 0.562 percent. This finding suggests that in the middle group, where additional income is slightly more allocated to food than in the poorer group. In the 75% quantile, with a lower income elasticity of 0.457, it shows that a one percent increase in household income significantly raises food expenditure by 0.457 percent. This group allocates a smaller proportion of income to food as income increases. Farmer households in the 90th quantile have a lower income elasticity of 0.372. The coefficient indicates that a one percent increase in household income significantly raises food expenditure by 0.372 percent. This means that wealthier households allocate more money to food than poorer households. This is consistent with Engel's law, which states that as income increases, the proportion of expenditure on food decreases. Based on the estimated income elasticities across the five quantiles, it can be concluded that the effect of income on food consumption expenditure is greater in the low-income group (lower quantile) than in the high-income group (upper quantile). This aligns with Engel's law, which states that poor households tend to allocate more of their additional income to food, while wealthier households spend less.

The TSLS estimation results (Table 4), it was found that, simultaneously, the variables of food consumption expenditure, technical efficiency, access to agricultural diversification, access to non-agricultural employment, land tenure status, access to credit, education, age, and gender have a significant influence on the per capita income of farming households. The partial effects of these variables are as follows: Food consumption expenditure has a positive regression coefficient and is significant for the per capita income of farming households. This study indicates that an increase in food consumption expenditure significantly enhances the per capita income of farming households. This finding suggests that farming households purchase food categorized as normal goods. This is supported by previous studies, which found that the increase in food consumption expenditure is driven by the improved quality of food purchased by households, particularly nutritious food (Chrisendo, Krishna, Siregar, & Qaim, 2020). Quality food is positively correlated with price (Anis, Rahman, & Khalid, 2022), so the higher the quality of food, the higher the food consumption expenditure. Consumption of healthy food products plays an important role in health (Szalonka et al., 2021). Waqas, Iqbal, and Stewart-Knox (2024) found that increasing food expenditure has a significant positive effect on mental health. In the relationship between food quality and health, the consumption of quality household food has a significant effect on improving health (Petrescu et al., 2020). Food is a key indicator of well-being in the domains of health, poverty, nutrition and food security (Zezza, Carletto, Fiedler, Gennari, & Jolliffe, 2017). The results of the study by Xie et al. (2020) found a positive and significant direct effect of health variables on labor income. Good health increases household income (O'Donnell, 2024).

Technical efficiency has a positive and significant regression coefficient for the per capita income of farming households. This finding indicates that technical efficiency significantly increases farming household income. The results of this study support the findings of Bravo Ureta, Jara Rojas, Moreira López, and Riveros Villegas (2021), which state that technical efficiency reflects the managerial performance of farmers in maximizing output from their farming activities. Our study is also consistent with the findings of researchers (Sumaryanto et al., 2023), which show that technical efficiency significantly enhances farming household income. According to Wang et al. (2023) improvements in agricultural production efficiency can reduce production costs, thereby increasing income in agriculture. Other than that, technical efficiency is the use of certain inputs to produce maximum or technologically feasible output conditions (Farrell, 1957) because achieving maximum production indicates maximum income in agriculture.

Agricultural diversification activities have a significant impact on the per capita income of farming households. Improved access to agricultural diversification activities significantly increases household per capita income. This study's findings are consistent with Ferrer et al. (2022), which states that rice farming households engaging in crop diversification achieve higher income compared to others. Additionally, Kurdyś-Kujawska et al. (2021) found that agricultural diversification activities significantly enhance the income stability of farming households. Diversification in agricultural and horticultural commodities, as well as other agricultural products with high prices, significantly increases the income of farm households (Ahmadzai, 2020). Apart from that, diversification activities can be carried out using agricultural land and other assets in the form of agritourism activities.

The off-farm work variable has a significant impact on the per capita income of farming households. This finding aligns with the studies of Neglo, Gebrekidan, and Lyu (2021), which state that non-agricultural employment has a positive and significant effect on household income. Several researchers have found that non-farm income has a

significant influence on improving the welfare of farming households (Odoh & Nwibo, 2016). This indicates that farm households with access to non-farm income are more prosperous than others. In other words, non-farm income has reduced poverty among farm households (Iqbal et al., 2018)

Land tenure status has a significant influence on the per capita income of farm households. Our results are in line with the findings of Deng, Zhang, and Wan (2022) that land tenure has a positive and significant influence on farm household income. This is because landowner farmers have higher productivity than tenant farmers (Mdoda & Gidi, 2023). Land tenure security has a positive and significant effect on the ease with which farm households can access credit, thereby increasing labor productivity (Mbudzya, Gido, & Owuor, 2022). Land tenure security, access to credit, and productivity are correlated; therefore, land tenure status has a positive and significant effect on increasing farm household income by mediating agricultural investment, wage increases, and income from other agricultural businesses.

Access to credit has a positive and significant effect on the per capita income of farming households. This study's findings align with those of Kumar, Mishra, Sonkar, and Saroj (2020), which indicate that credit positively and significantly impacts household per capita income. Toure (2021) found that access to formal credit has a positive and significant effect on farm income. The effect of credit access on farming household income is due to farmers' increased ability to adopt agricultural technologies, leading to higher agricultural production (Girma, 2022). Access to credit has a significant effect on the productivity of agricultural commodities (Mbudzya et al., 2022).

The education of the household head has a positive and significant effect on the per capita income of farming households. This finding is supported by previous studies, Cuong and Vu (2023), which demonstrate a positive and significant influence of education on agricultural household income. This condition is particularly evident in the adoption of more effective agricultural technologies and sustainable land management, which in turn increases farmers' income (Issahaku & Abdulai, 2020). Furthermore, highly educated farmers possess specific knowledge and facilitate the application of management techniques in modern agricultural production, which impacts increasing farm income (Deng et al., 2022).

Age has a negative and significant effect on the per capita income of farming households. The study results state that the older the age of the farmer household head, the lower the income from the agricultural sector. The findings of this study are in line with the results of Kumar et al. (2020) that the age of farmers has a significant and negative effect on household income. The negative effect of the old age of household heads on income from agriculture may be due to the ability to adopt agricultural technology and low education. Dissanayake, Jayathilake, Wickramasuriya, Dissanayake, and Wasala (2022) found that older farmers have more farming experience, younger farmers have higher education. Consequently, the ability of older farmers to adopt agricultural technology is lower than that of younger farmers. Furthermore, Sahara et al. (2023) found that the age of the head of the farmer household affects the technical operation of the farming process, which will affect agricultural income.

The gender variable has a negative and significant influence on the per capita income of farm households. This finding indicates that female-headed households have higher per capita income than male-headed households. This may be due to differences in participation between male and female household heads in paddy rice farming. Mwalyagile, Jeckoniah, and Salanga (2024) in their study found significant differences ($p < 0.01$) in gender participation in rice production, where men had higher participation than women. Women's participation was mainly in seeding, planting and weeding activities. This condition may encourage women to seek other sources of income. Study results Antriyandarti, Suprihatin, Pangesti, and Samputra (2024) show that women have a key role in household management, therefore have various sources of income in dealing with climate change in the agricultural sector. Islam et al. (2022) found that women's income from off-farm activities had a significant impact on household income.

The estimation results of household expenditure using TSLS (Table 5) show that, simultaneously, the variables of income, access to credit, age, gender, location, marital status, and education have a significant impact on the household consumption expenditure of farming households. The influence of each exogenous variable is as follows:

Income has a positive and significant effect on the per capita food consumption expenditure of households. This finding suggests that the higher the income, the higher the food consumption expenditure, assuming ceteris paribus. The positive coefficient value indicates that the food commodities consumed are normal goods. This finding is in line with Pallegedara (2019) that food expenditure elasticities for all major food types of sample households in Sri Rare indicate normal goods. This finding is supported by studies Tesgera et al., 2024), which show that household income is a significant determinant of food expenditure. An increase in income leads to higher consumption of high-quality and diverse food, as well as a more balanced diet with higher nutritional value (Ferrier & Zhen, 2017). Rathnayaka, Selvanathan, and Selvanathan (2022) also found a positive and significant income effect on the demand for food commodities of residents of Asian countries with high incomes by consuming diversified food products, while those with low incomes consume less diversified food commodities. Furthermore, Baladina, Toiba, Hanani, Suhartini, and Widarjono (2024), through a study in Indonesia, found that the effect of income is positive and significant on food demand for carbohydrate nutrition and animal protein. Previous studies in Vietnam have found that the effect of increasing household income is to increase consumption of high-value foods such as fresh vegetables, fish, milk, chicken and fruits (Bairagi, Mohanty, Baruah, & Thi, 2020). In the Philippines, the elasticity of demand for rice in low-income households is more elastic than in high-income households (Valera, Mayorga, Pede, & Mishra, 2022). For households with high incomes, the income effect is illustrated through the types of food commodities consumed such as meat, dairy and aquatic products that have high prices (Ren, Zhang, Loy, & Glauben, 2018). The income effect has also increased farmers' access to nutritious food purchased from the market, which has led to an increase in household expenditure on food and nutrients such as iron, calories, zinc, and vitamin A (Chrisendo et al., 2020).

Access to credit has a positive and significant regression coefficient for the food consumption expenditure of farming households. The results of this study are consistent with the findings of Ma, Nie, Zhang, and Renwick (2020)

which show that access to credit increases food consumption expenditure. The availability of access to credit can help balance household consumption patterns (Tesgera et al., 2024). The significant and positive role of credit in enhancing household food security is also highlighted in (Boltana, Tafesse, Belay, Recha, & Osano, 2023). Credit access has a positive influence on household nutrition, specifically on calorie intake, zinc, and iron levels, but formal credit access has a negative impact on vitamin A nutrition (Chrisendo et al., 2020). The importance of credit access for agricultural households was found in the study of Salima, Manja, Chiwaula, and Chirwa (2023) that access to formal credit has a positive impact on household food security, especially during droughts and floods.

Age has a positive and significant effect on the per capita food consumption expenditure of farming households. This finding is consistent with previous studies that show the age of the household head has a positive effect on food expenditure (Ramdhanie et al., 2017). The above findings are also supported by Lasitya et al. (2022) which found that the age of the household head has a positive and significant impact on the expenditure on protein-rich food. In the elderly, the main food demand is healthy food based on recommendations from health institutions (Adebayo et al., 2017). In this regard, an increase in the aged population has a significant effect on the diversity of food consumption in urban areas, but this condition does not apply to the rural population because it can lead to a decrease or increase in the consumption of certain food products (Li, Chen, Ren, & Glauben, 2024). The above findings indicate that age structure can have positive or negative effects on food demand and food expenditure.

Gender has a negative and significant effect on per capita food consumption expenditure of farming households. This finding indicates that households headed by women tend to have higher food consumption expenditure compared to other households. This is likely related to the role of women in determining family nutrition (Lecoutere & Jassogne, 2019). It is related to gender where women are the determinants of healthy food consumption (Adebayo et al., 2017). Within a household, women are significantly more likely than men to prioritize plant-based protein consumption and sustainable food practices (Culliford & Bradbury, 2020). Previous studies have found that the effect of gender in female-headed households on family nutrition intake can be positively or negatively influenced by employment type. For female-headed households with off-farm jobs, there is a significant positive effect on family nutrition (vitamin A, zinc, calories, and iron). For households headed by females who only work on farms, the gender effect is negative and significant on family nutrition (Chrisendo et al., 2020). This finding indicates that the effect of gender on food expenditure can be positive, where male household heads significantly increase food expenditure, or negative, where female household heads are the determinants of food expenditure. The results of the Gómez-Valle (2023) found that women's income increased the amount of household food expenditure significantly more than men's income.

In contrast to the above findings, Mulamba's (2022) study found a positive and significant effect of gender on household food expenditure. This finding indicates that food expenditure in male-headed households tends to increase when compared to female-headed households. Ahmed (2023) found that the increase in expenditure of male-headed households was due to an increase in the purchase of food outside. From the findings of previous studies, it can be shown that the effect of gender on food expenditure varies, with a significant positive or negative effect. However, gender has no significant effect on household expenditure inequality (Jayasinghe, 2019).

Location has a positive and significant effect on household food consumption expenditure. The results of this study are consistent with the findings of Htar et al. (2022), which show that as households move closer to urban areas, per capita food expenditure tends to decrease. Some researchers, Li et al. (2024) that the location effect is negative on food expenditure; therefore, household food expenditure in urban areas is greater than in rural areas. Furthermore, the study results of Ahmed (2023) show that the location variable has a negative, but insignificant coefficient on household food expenditure in the form of processed food commodities from outside.

Marital status has a positive and significant effect on household food consumption expenditure. The results of this study are consistent with the findings of Rashid et al. (2024). Additionally, Kostakis et al. (2020) also found that marital status has a positive impact on per capita food consumption. In general, researchers will find that marital status has an effect on household food expenditure. Furthermore, Zanquet, Tezza, and Kieling (2024) found that marital status has an effect on food choices, the usefulness of commodities purchased, and the perceived price of online food products. The effect of marital status on household food expenditure may vary among studies due to other factors such as family size and age variables that can influence it, such as the results of the study of Omotoso, Aj, Ma, and Om (2022) found that marital status has a positive but insignificant effect on household food expenditure. Mulamba (2022) found that households where the head of the household is married tend to experience a decrease in income contribution to food expenditure.

Education has a positive and significant regression coefficient for the per capita food consumption expenditure of farming households. This finding means that the higher the education level of the household head, the higher the per capita food consumption expenditure, assuming ceteris paribus. Household heads with higher education are more selective in purchasing quality food products. Salo et al. (2021) found that household heads with higher education spend more on purchasing quality food. This study's findings are also supported by the research of Htar et al. (2022), which shows that the education level of the household head has a positive impact on food expenditure. Previous researchers have found that formal education of the household head has a positive and significant effect on increasing household food expenditure through increased demand for each food commodity and household diet (Pallegedara, 2019). The positive effect of education on food demand is in the form of the consumption of nutritious food products. The study results of Islam and Sim (2021) found that education has a positive and significant effect on the percentage of consumption of healthy food products in households. Consumption of healthy food among highly educated households is 31.5% higher than among other households. In addition to affecting consumption, education also influences higher income, enabling households to purchase various food products in the market through offline or online channels.

The quantile regression estimates, it was found that the income elasticity (E) values in the five quantile groups are E < 1. (Table 6), this value indicates the applicability of Engel's law in this study. The above findings are in line with the study of Kostakis et al. (2020) that there is a positive and significant relationship of total income with food expenditure or an inverse U-shaped relationship. In other words, there is a non-linear relationship between the share of food budget in total expenditure and income. Ren et al. (2018) found the applicability of Engel's law in rural China. A one percent increase in income results in an increase in food expenditure of 0.69 percent among low-income households, whereas in high-income households, a one percent increase in income leads to a 0.12 percent rise in food expenditure.

5. CONCLUSION

This study analyzes: 1) the effect of technical efficiency variables, agricultural diversification, off-farm work, land tenure status, credit access, education, age, gender, and food consumption expenditure on household income of paddy field farmers; 2) the influence of household income, credit access, education, age, gender, village/city (location), and marital status on food consumption expenditure. Data analysis using TSLS is employed because household income and food consumption expenditure are endogenous variables, and the use of OLS could cause bias. This study also calculates income elasticity using quantile regression to assess the applicability of Engel's law.

Based on the analysis, the following findings were obtained: 1) Variables such as food consumption expenditure, technical efficiency, off-farm work, diversification in agriculture, land tenure status, access to credit, and education have a positive and significant influence on the per capita income of farm households. This indicates that increases in these variables will significantly raise the per capita household income of farmers. Conversely, age and gender have a negative and significant effect on household income. 2) Variables including per capita income, access to credit, age, location, marital status, and education positively and significantly influence per capita food consumption expenditure of farmer households. This suggests that increases in these variables will significantly enhance food consumption expenditure. In contrast, gender has a negative and significant impact, highlighting the important role of women in farmer households. 3) Income elasticity across all quantiles has a value of E

6. IMPLICATIONS FOR RESEARCH, PRACTICE AND/OR SOCIETY

For further research, it is recommended to analyze the direct influence of food consumption expenditure variables on farmer household income and to examine the indirect effects mediated by health variables on farmer household income.

From the above findings, there is a need for government policies related to welfare, such as food price policies, to increase the purchasing power of farming households for quality food products. Policies on grain prices should aim to increase the income of rice-farming households. Policies targeting increased income for the poor will have a greater impact on improving their food consumption than those aimed at the wealthy.

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