



# Determinants of Dryland Farmer Household Food Security

Endang Tri Astutiningsih<sup>1</sup>, Bonar M. Sinaga<sup>2</sup>, Nunung Kusnadi<sup>2</sup>, Handewi P. Saliem<sup>3</sup>

<sup>1</sup> Universitas Muhammadiyah Sukabumi, Sukabumi, Indonesia.

<sup>2</sup> Institut Pertanian Bogor, Bogor, Indonesia.

<sup>3</sup> Pusat Studi Sosial Ekonomi Pertanian, Bogor, Indonesia.

Received: November 12, 2025

Revised: December 22, 2025

Accepted: January 25, 2026

Published: January 31, 2026

Corresponding Author:

Endang Tri Astutiningsih

[end.end2016@ummi.ac.id](mailto:end.end2016@ummi.ac.id)

DOI: [10.29303/jppipa.v12i1.13853](https://doi.org/10.29303/jppipa.v12i1.13853)

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**Abstract:** Food security is a central issue that must be realized at the household level. Poverty and food insecurity are the most common problems faced by people living in drylands. This study aims to analyze the food security status of dryland farmer households and the factors that determine it. The unit of analysis in this study is dryland farmer households growing upland and paddy rice in Sukabumi Regency, West Java. Food security is analyzed using descriptive methods, while its determinants are analyzed using a simultaneous equation model estimated by the 2SLS method. The research results show that farmer households are in a state of food insecurity. The energy consumption rate, as an indicator of food security, is significantly influenced by both food and non-food expenditures. Upland rice production positively affects the value of food reserves, and its development can support the realization of household food security in drylands.

**Keywords:** Drylands; Farmer households; Food security

## Introduction

Food security must exist not only at the regional level but also at the household level. Oftentimes, food security at the regional (macro) level does not represent food security at the household level. Research by Rachman et al. (1996) showed that sufficient food availability at the national and regional levels did not necessarily eliminate food insecurity. In fact, the FAO (2014) also states that even though the dimensions of availability, access, stability, and utilization have met the criteria for food security, this does not guarantee that the problem of food insecurity at the household level has been resolved. Factors such as hygiene and food processing, price instability, economic crisis, and food distribution are often considered other factors that interfere with household food security, thereby requiring policies to address them.

Household food security often goes hand in hand with poverty levels. Poor households have low purchasing power, resulting in low access to quality

food and unbalanced food consumption patterns (Bhattacharya et al., 2004; Badan Ketahanan Pangan, 2018). The low human resource quality, limited carrying capacity of agricultural land, facilities, and infrastructure, and weak control of agricultural land and livestock resulted in the average income of the population below the poverty line and were included in the category of areas with high food insecure households (Purwantini & Ariani, 2007). Agriculture in dryland agroecosystems is often characterized by poverty and food insecurity. The results of Harniati (2007) research showed that agroecosystems influenced poverty levels, with residents in drylands tending to have higher poverty levels than those in paddy fields. Similar results were also found in Nusa Tenggara Timur (East Nusa Tenggara) (Riptanti et al., 2020), Bantul Regency (Susilowati, 2016), and Vietnam (Pandey et al, 2006).

According to the 2013 Agricultural Census, non-paddy agricultural land accounted for 77% of total agricultural land includes dryland in Indonesia. Dryland farming faces conditions of limited water

## How to Cite:

Astutiningsih, E. T., Sinaga, B. M., Kusnadi, N., & Saliem, H. P. (2026). Determinants of Dryland Farmer Household Food Security. *Jurnal Penelitian Pendidikan IPA*, 12(1), 818-824. <https://doi.org/10.29303/jppipa.v12i1.13853>

sources, low soil fertility, inaccessible locations far from markets, and low productivity (Pandey et al, 2006; Edy & Widjojoko, 2009). The diversity of farming products in drylands includes food crops, non-food crops, livestock, and plantations. Food crops grown in drylands include upland rice, soybeans, corn, peanuts, cassava, and sweet potatoes. Thus, increasing upland rice production is one of the efforts to utilize dryland and support the achievement of food security (Irawan & Pranadji, 2016) and rice self-sufficiency (Mulyani et al., 2017).

In addition to income from farming various commodities, farmer households also often earn income from non-agricultural activities (Asmarantaka & Winandi, 2009; Edy & Widjojoko, 2009; Mariyanto et al., 2016). Farmer household income will affect household production and consumption, as farmer households in developing countries play a dual role as consumers and producers (Singh & Strauss, 1986; Kusnadi, 2005). Household income affects household consumption decisions for both food and non-food items. Farmer household income will also affect food security (Rachman & Suhartini, 1996).

Based on the 2019 food security index, West Java province ranked 8th out of 44 provinces in Indonesia with a score of 76.44. For Sukabumi Regency, the score was 74.50, indicating it is in group 5, where food security is poor or vulnerable to food insecurity (Badan Ketahanan Pangan, 2020). In 2020, 59.91% of per capita expenditure in Sukabumi Regency was spent on food, and 40.09% on non-food (BPS Sukabumi, 2020). Responsibility when community members are unable to meet their basic food needs (Mattila-wiro, 1999). For this reason, a study on the food security of dryland farming

households was conducted to define the status of food security and the factors that determine it. This study is expected to serve as a reference for formulating policies that achieve food security for dryland farmer households.

### Method

This research was conducted in Sukabumi Regency, West Java, Indonesia. This area was purposively selected (Sugiyono, 2018; Mukhlis et al., 2019; Mukhlis et al., 2024), because it has extensive drylands and farmers grow upland rice and paddy rice. Sukabumi Regency is the second-largest dryland area in West Java, after Garut. Respondents of this study were 100 farmer households who grew up land and paddy rice in the last planting season. Respondents were selected using the snowball sampling method, as in the previous planting season, many farmers were unable to grow upland rice because the land was too dry. The snowball sampling method can be used when researchers have difficulty finding or identifying the population and the number cannot be determined accurately (Nurdiani, 2014; Mukhlis et al., 2023). The snowball sampling method is a survey research method used if the sample is obtained through a rotation process from one respondent to another (Neuman, 2014).

The food security of farming households is measured using a cross-tabulation of two food security indicators, namely the share of food expenditure and the level of energy consumption, according to Maxwell et al. (1992), which are expressed in the following table.

**Table 1.** Measuring the Level of Household Food Security

Energy Consumption Level	Food Expenditure Share	Food Expenditure Share
	Low (<60% Total Expenditure)	High (≥60% Total Expenditure)
Sufficient (>80% Energy Sufficiency)	Food Security	Food Vulnerability
Deficient (≤80% Energy Sufficiency)	Food Deficiency	Food Insecurity

Food expenditure share is the percentage of food expenditure to total household expenditure. The relationship can be formulated as follows:

$$RPPN = (PPN)/PTRT * 100 \tag{1}$$

Descriptions:

RPPN= Food Expenditure Share (%)

PPN= Food Expenditure (Rp/year)

PTRT= Total Household Expenditure (IDR/year)

The level of energy consumption (DKE) and the energy consumption rate/amount (AKE) are expressed in the following formula:

$$DKE = AKE / (\text{recommended AKE}) \times 100\% \tag{2}$$

$$[AKE]_i = \sum_{k=1}^8 C_{mk} \times KdE_k \tag{3}$$

Descriptions:

DKE Energy Consumption Level

AKE<sub>i</sub> Amount of Energy Consumed

C<sub>mk</sub> Type of Food Consumed (gram)

KdE<sub>k</sub> Energy Content of Food Commodities (%)

k= Type of Food (k = 1, 2, ..., 8)

Total Energy Consumption (AKE) is the total amount of energy consumption of a household calculated based on the Food Consumption List (DKBM). The recommended AKE is based on the results

of the XIth Widyakarya Nasional Pangan dan Gizi (WKNPG) in 2018, which recommends an Energy Consumption Rate of 2100 Kcal/cap/day, while the Protein Adequacy Rate (AKP) is 57 grams/cap/day. The XIth Widyakarya Nasional Pangan dan Gizi (WKNPG) or National Workshop on Food and Nutrition in 2018 recommended an energy consumption rate of 2100 kcal/cap/day, while the protein sufficiency rate (AKP) is 57 grams/cap/day. The determinants of food security in this study were analyzed using a simultaneous equation model. Parameters were estimated using 2SLS. The model consisted of 8 equations with the following specifications:

$$PDRT_i = PDPG_i + PDPS_i + PDUTNP_i + PDNP_i + NWI_i \quad (4)$$

$$PDDI_i = PDRT_i - PAJK_i \quad (5)$$

$$PRT_i = PCON_i + INT_i \quad (6)$$

$$PCON_i = PPN_i + PNPN_i \quad (7)$$

$$PPN_i = a_0 + a_1 PDUTNP_i + a_2 PDNP_i + a_3 NQPTJ_i + a_4 JAK_i + U1_i \quad (8)$$

$$PNPN_i = b_0 + b_1 PDDI_i + b_2 NQPTJ_i + b_3 JAK_i + U2_i \quad (9)$$

$$AKE_i = c_0 + c_1 PPN_i + c_2 PNPN_i + c_3 INT_i + U3_i \quad (10)$$

$$NCP_i = d_0 + d_1 QPG_i + d_2 PRT_i + d_3 JAK_i + U4_i \quad (11)$$

Descriptions:

PDRT= Household Income

PDPG Upland Rice Farming Income

PDPS Paddy Rice Farming Income

PDUTNP = Non-rice Farming Income

PDNP= Non-agricultural income

NWI= Non-working Income

PDDI= Disposable income

PAJK= Tax

PCON= Consumption Expenditure

INT= Investment Spending

PNPN= Non-Food Expenditure

NCP Value of Food Reserves

QPG Upland Rice Production

JAK Number of Family Members

NQPTJ = Value of Paddy Rice Production that is not Sold

a, b, c, d = Coefficients of Equation

i= Ith respondent and i = 1, 2, 3...

## Result and Discussion

### Characteristics of Respondents

On average, dryland farmer households have three family members, with the education level of the household head and wife not completing the 9-year compulsory education program. This information is important because the level of education affects household decision-making, both in production and

consumption. The above statement is consistent with the findings of Hardono (2002) and Sihite (2011), who reported that the educational level of the head of the farmer household in rural areas remains low. Research by Anggitasari et al. (2021) indicates that a wife's educational level can affect household food security.

Farmer households, in terms of land area, are still classified as having narrow land. The average land area for upland rice is 0.63 ha, and 0.39 ha for paddy rice. Land ownership status for paddy rice is mostly self-owned, whereas upland rice is mostly owned by plantations/forestry. Upland rice is cultivated once a year, and rice paddy is cultivated twice a year. In 2019, the average paddy rice productivity was 6,357 kg/ha, with production mostly carried out in the lowlands or in areas close to water sources. The average productivity of upland rice was 3,313 kg/ha with cultivation carried out in upland areas or plantations (intercropping with crops such as coconut and others) and far from residences. The productivity of upland rice is still very low because the seeds used are paddy rice seeds and/or from the previous harvest, whereas many certified upland rice seeds have been found to yield more than 5 tons per hectare (Hairmanis, 2015).

In addition to rice farming as the main source of income, most farmer households also obtain income from non-rice farming (corn/soybean, coconut, papaya, and others), non-agricultural business activities (motorcycle taxis, trading, part-time labor, and others), also a small number of farmers have other sources of income in the form of remittances from children or relatives on a regular basis called non-working income (NWI). The contribution of income from farming (paddy, upland, non-rice) is 51.36%, non-agriculture is 38.94%, and NWI is 10.04%. The results of this study are in line with those of Asmarantaka (2007), which found that cassava food villages have a larger share of non-agricultural income than rice food villages.

### Food Security Status of Farmer Households

The results showed that dryland farmer households were mostly in a state of food insecurity (98%) and food deficiency (2%); no households were in a state of food security. A household with a state of food deficiency (2%) is a condition where the degree of energy sufficiency is less than 80% with food expenditure less than 60%. For farmer households in a state of food insecurity (98%), the degree of energy sufficiency remains below 80%, and the share of food expenditure exceeds 60% of household expenditure. To achieve food security criteria, households must manage their food consumption expenditure to less than 60% while meeting their energy needs of more than 80%. The share of food expenditure above 60% and non-food

expenditure at 40% indicates that the household is in a low-income state, as most of its income is spent on food. Moreover, under such conditions, the food consumed does not meet the recommendations required to fulfill their energy needs.

The average share of food expenditure of farmer households is 73.29% of total household expenditure per month. The largest portion was spent on staple foods, namely rice. This shows that most household expenditure is still on food, so the annual household food expenditure remains high. Details of household expenditure are shown in the following table.

**Table 2.** Food Expenditure of Dryland Farmer Households in Sukabumi Regency in 2019 (Per Month Per Capita)

Type	Percentage (%)
Grains	25.03
Tubers	0.49
Animal-Source Food	20.04
Oil and Fat	4.05
Nuts	7.50
Vegetables and Fruits	16.15
Sugar and Beverage Ingredients	5.59
Cigarettes and Tobacco	17.54
Others	3.61
Total	100.00

The table above shows that animal-source food consumption amounted to 20.04%. Most of the animal-source foods consumed are salted fish, which are easy to

find and buy. Another fact also shows that the consumption of cigarettes and tobacco is higher than the consumption of vegetables and other foodstuffs. This illustrates the behavior of dryland farming households that prioritize cigarette consumption over healthy, nutritious food to achieve food security.

If referring to the 2018 Widya Karya Pangan dan Gizi Nasional (Widya Karya National Food and Nutrition) recommendations, the energy sufficiency level of farmer households is 71.27%, and the protein sufficiency level is 96.58%. This differs from the results of Hardono's (2002) research, which found that areas outside Java with non-farm agroecosystems have energy and protein sufficiency levels of 90.2% and 103.2%, respectively. These sufficiency levels are higher than those in Java or areas with rice paddy agroecosystems. The energy and protein content refer to the 2008 Indonesian Food Composition Table list. The following table illustrates the average energy and protein consumption of dryland farmer households in Sukabumi Regency.

Table 3 shows that the largest contributions to energy and protein come from staple foods, namely rice. This shows that the dependency of farmer households on rice remains very high, and that food diversification has not yet developed at the household level. This condition confirms Purwaningsih's (2008) findings, which state that the Indonesian population's energy consumption is still sourced from grains, particularly rice. Thus, there must be an effort to sensitize the community to diversify food by developing local food and optimally utilizing the land around them.

**Table 3.** Calorie and Protein Consumption of Dryland Farmer Households in Sukabumi Regency in 2019 (kcal/capita/day)

Type	Consumption			
	Energy	%	Protein	%
Grains	786.22	49.34	29.83	55.19
Tubers	12.48	0.78	0.09	0.16
Animal-Source Food	165.16	10.37	17.83	32.39
Oil and Fat	301.49	18.92	0.14	0.25
Nuts	41.40	2.60	2.18	3.96
Vegetables and fruits	81.51	5.12	1.96	3.56
Sugar and Beverage Ingredients	138.88	8.72	0.36	0.65
Others	66.19	4.15	2.66	4.83
Total	1593.32	100.00	55.05	100.00

*Determinants of Food Security of Dryland Farmer Households*

Analysis of the determinants of food security was conducted using the estimation results from the previously mentioned equations. Food security in this model is measured using indicators of energy consumption rate (AKE) and food reserve value (NCP).

Based on the calculation of the level of energy sufficiency/consumption, which is still below the standard, food security is considered better when the energy consumption rate and the value of food reserves increase. The estimation results are shown in the table 4.

The table 4 indicates that food expenditure is influenced by non-rice farm income, non-agricultural

income, and the number of family members. The results confirm the findings of Anggitasari et al. (2021), who found that household income and the wife's education affect household food security. In this study, the income from non-rice farming and non-agricultural activities is determined by the allocation of household time across both activities. When households spend more time on non-rice farming and non-agricultural activities, they must purchase daily food, including rice, from others. Non-rice commodities here can include food

commodities such as corn and soybeans, as well as small livestock and coconut plantations. Meanwhile, non-agricultural activities include construction labor, trade, and services such as motorcycle taxis. This is in line with the findings of Hardono (2002) and Asmarantaka (2007), which indicate that food expenditure is influenced by non-rice and non-agricultural income and the number of household members. Non-food expenditure is influenced by disposable income, the value of unsold paddy, and the number of family members.

**Table 4.** Parameter Estimation Results of the Food and Non-Food Expenditure Equation in Sukabumi Regency in 2019

Equation	Variable	Parameter Estimation Value	Pr> t	Elasticity
<b>Food Expenditure (PPN)</b>				
Intercept	Intercept	10196.9900	<0.00005	-
Non-rice farming income	PDUTNP	0.3339	0.0008	0.0832
Non-agricultural income	PDNP NQPTJ	0.0464	0.0999	0.0359
Value of unsold paddy	JAK	0.0139	0.2638	0.0537
Number of family members		1060.0130	0.0395	0.2172
<b>Non-Food Expenditure (PNPN)</b>				
Intercept	Intercept	3449.8380	<0.0025	-
Disposable income	PDDI	0.0122	0.1537	0.1265
Value of unsold paddy	NQPTJ	-0.0240	<0.0299	-0.2831
Number of family members	JAK	818.8009	0.0028	0.3478
Intercept	Intercept	1097.7310	<0.00005	-
Food expenditure	PPN	0.0403	<0.00005	0.4499
Non-food expenditure	PNPN	-0.0296	0.0651	-0.1070
Total Investment	INT	-0.1778	0.0165	-0.0797
<b>Food Reserve Value</b>				
Intercept	Intercept	45228.70	<0.0001	-
Upland rice production	QPG	8.7166	<0.00005	0.4399
Total household expenditure	PTRT	-0.3475	0.1544	-0.1247
Number of family members	JAK	-763.0700	0.3898	-0.0412

Energy consumption rates are influenced by food and non-food expenditures and by household investments. An increase in food consumption expenditure can increase energy consumption, assuming the increase is to obtain better food. Food expenditure is positively influenced by non-rice and non-agricultural income and the number of household members. Non-rice farming in the study area includes fruits and plantation crops such as coconut and its products, as well as large and small livestock businesses. Different sources of income for farmer households help anticipate the risks of dryland agriculture and increase households' ability to meet their needs (Asmarantaka, 2007; Mariyanto et al, 2015). The greater the number of family members, the lower the energy sufficiency rate that can be realized by farmer households. This confirms the results of research by Purwantini et al. (2005), which found that a large number of household members

worsens household resilience; in other words, the energy sufficiency rate is also declining.

Increasing household energy consumption rates should be done by increasing food expenditure. The results of this study are in line with Sihite (2011) research, which found that food expenditure affects household food security. Increased food expenditure can improve food security if the expenditure is done wisely and with full awareness of the importance of healthy food consumption. The high rate of cigarette expenditure among dryland farmers needs to be evaluated, and awareness of the importance of a healthy lifestyle and of food consumption must be instilled so that cigarette consumption can be reduced and redirected toward healthy food. Non-food expenditure negatively affects food security, meaning that energy consumption decreases as non-food expenditure increases.

Most farm households (59%) use the upland rice they produce for their own consumption. As for paddy rice, most farmer households (87%) sell it to the market. Upland rice production in this model has a positive effect on the value of food reserves; thus, increasing upland rice production increases the value of food reserves. The value of unsold rice minus the value of consumed rice represents the value of food reserves held by households. The value of food reserves reflects the availability of rice, the staple food for households.

Upland rice production in this study can affect the value of food reserves. Thus, upland rice production, in addition to being a source of income, can also help achieve food security for dryland farmer households. This is in line with the research by Pandey et al. (2006) in Vietnam on the important role of upland rice in optimizing dryland use and supporting household economies. The production of upland rice needs to be increased by using quality upland seeds, appropriate cultivation techniques, and dryland processing technology.

## Conclusion

Dryland farmers are in a state of food insecurity. Food security improves with increased energy consumption and food reserves. Energy consumption levels are influenced by food and non-food expenditures. Food expenditures are influenced by non-rice and non-agricultural income. The value of food reserves of dryland farmer households is influenced by highland rice production and household food expenditures. Increased dry highland rice production must be carried out intensively, using registered seeds and appropriate cultivation technologies. The development of non-rice and non-agricultural activities needs to be increased to boost household income, thereby achieving food security. Efforts are needed from relevant parties to raise public awareness about healthy lifestyles and food consumption, so that food expenditure has a positive impact on food security.

## Acknowledgments

The authors would like to express their deepest gratitude to the Director General of Higher Education, Institut Pertanian Bogor (Bogor Agricultural Institute), and Universitas Muhammadiyah Sukabumi (Muhammadiyah University Sukabumi) for the opportunity provided.

## Author Contributions

E.T.A.: Developing ideas, data collection, analyzing, writing, reviewing, responding to reviewers' comments; B.M.S., N.K., H.P.S.: supervising data collection, analyzing data, reviewing data and writing.

## Funding

This research received no external funding.

## Conflicts of Interest

The authors declare no conflict of interest.

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