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Food insecurity among female farmers in rural West Sleman, Indonesia

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Abstract

Background Farmers, especially females, face the risk of food insecurity for their families. It would be interesting to examine the efforts made by female farmers who experience food insecurity due to the indirect impacts of COVID-19. This study aims to determine how female farmers deal with food insecurity risks in West Sleman. Data on food insecurity experiences are processed with Winstep software and the Rasch model. Ordinal logistic regression analysis calculates the probability of food insecurity for female farmers depending on their traits and the mitigation strategies they adopt.

Results The findings of this research show that agricultural laborers (42.3%) are the most numerous type of female farmer, followed by land-owning farmers (40.4%) and land-tenants farmers (17.3%). Although more than 50% of the three types of farmers are food secure, laborers have a higher percentage of moderate-to-severe food insecurity (23%) than land owners (14%) and land tenants (11%). Factors that influence the occurrence of food insecurity are not using the home yard, which is physically accessible to grow food, having an agricultural income of less than IDR 500 thousand, and a house asset value of less than IDR 100 million.

Conclusions Coping strategies for mitigating the risk of food insecurity start from within the family by prioritizing food spending, living frugally, growing food crops in your yard, committing full-time to farming, and avoiding dependence on government assistance. Then, optimizing and strengthening the community.

Keywords Female farmers, Food insecurity, FIES, Coping strategy, Economic access, Physical access

Introduction

Food insecurity is still a big problem for developing countries, especially in Asia and Africa. It refers to previous research in the *Agriculture and Food Security Journal*. The majority of them can be found in African countries including Tanzania [1], Ethiopia [2], Democratic Republic of Congo [3], sub-Saharan Africa [4], Ghana [5], Uganda [6], and South Africa [7]. Even though there are many developing countries in Asia, the issue of food insecurity is still relatively little addressed in research—Iran is one example [8]. Therefore, we are excited to raise the issue of food insecurity in Southeast Asia, especially in Indonesia. In addition, considering that women play an essential role in the issue of family food insecurity, more diverse research contributions are needed. Research from a range of emerging economies helps map the conditions of food insecurity and identify alternate ways for overcoming it, taking into account the unique experiences of each area. Females are crucial to managing households, mainly when producing and consuming food through agriculture. The measure "Average years of schooling for girls over 15 years", which assesses the degree of food security based on the aspect of food utilization, illustrates the contribution of females to food security in Indonesia

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[9]. Highly educated females are better equipped to handle and use food that satisfies their families and children's nutritional needs and health conditions. On the other hand, females are crucial in supporting the family economy in providing for the needs of their families. In rural areas, agricultural work is one way women financially support their families. Females are used to working in the fields alongside their husbands or families, particularly in the Java region. They assist with food preparation and agricultural tasks, among other things. If women do not possess fields, they will work in agriculture. Females made up 37.47% of laborers and employees in agriculture, compared to 42.93% of men, according to data from BPS Sakernas (Central Statistics Agency, National Labour Force Survey) [10]. DI (Special Region) Yogyakarta is one of the 34 Indonesian provinces that has the second-highest percentage of working-age females (64.33%) in 2020, behind Bali (67.86%).

Indonesia's economic growth in Quarter II -5.32 [11, 12] raised the country's poverty rate from 9.22 percent to 10.19 percent. Since the emergence of Covid-19, other nations have also seen a decrease in their economic conditions [13]. In addition, restricting population mobility across areas also negatively impacted the agricultural sector, which suffered the most from the nation's economic downturn. Farmers themselves felt the impact due to the decline in agricultural revenue. Poverty rates will rise, particularly in rural communities that rely heavily on agriculture. The most vulnerable categories include female-headed households, low-income households, and households with low levels of education, according to research findings [4, 14]; these data also corroborate the disastrous effect of COVID-19 in worsening food insecurity. According to [11, 15], females are more susceptible to food insecurity than men; these studies focus on the connection between gender, food, and climatic challenges. The level of food insecurity females face due to the negative impact of COVID-19 varies depending on their demographics and where they live (rural or urban). New migrants living in metropolitan areas should be aware that access to the economy influences their level of food insecurity [16]. People with low incomes feel satisfied when they use food-sharing social networks. In contrast, high-income communities do not need local assistance because they do not face economic access barriers. Other factors that affect an individual's capacity to lower their risk of food insecurity include their educational background [17], the hardship of having a large family [18], and where they live (rural or urban) [19]. Looking at several previous studies, researchers assess that the risk of food insecurity is highest in rural areas [17, 18], the agricultural sector [5, 11, 20], and females [3,

7]. To combat food insecurity, researchers highlight the experiences of women farmers who live in rural areas and work in agriculture. However, the issue of food insecurity experienced by women requires more varied study contributions with different methodologies and places. However, as per research findings [3], females who take part in resource allocation can lower the likelihood of food insecurity in the home. Stated differently, females are both subjects susceptible to experiencing food insecurity and figures who actively participate in developing measures to overcome it. These are two exciting lessons that warrant discussion in this piece.

This study occurred in the province of DI Yogyakarta's rural Sleman district. During the COVID-19 pandemic, this region's poverty rate rose by 12.8 percent in 2020 compared to 11.44% the year before, the most significant increase among Indonesia's regions. The rising percentage of poverty reflects people's limited ability to purchase food from the market. DI Yogyakarta's food security score dropped from 83.63 in 2019 to 81.43 in 2020 after the outbreak. Additional results from the Food Insecurity Experience Scale data, which the Central Statistics Agency (BPS) analyzed, indicate that DI Yogyakarta is part of ten provinces with a prevalence rate of 62.5% with moderate-to-severe levels of food insecurity. [21]. The Rasch model analyzes the FIES data, one of the instruments used to quantify food insecurity, to ascertain the degree of food insecurity. This technique was applied in the research of [22], explaining why 15% of the LAS (League of Arab States) region's countries are having severe food insecurity. The fact that farmers' income from the agriculture sector might account for up to 72% of their household income [4] is the driving force behind their low purchasing power. Dependence on one's household is another aspect, particularly in DI Yogyakarta Province, where rice is the staple diet. The impact of the Covid-19 pandemic (rice production in Sleman Regency fell by 2.8% from 65,292 tonnes in 2019 to 63,436 tonnes in 2020) [23] and the impact of climate change (an increase in land salinity levels) [24] have added to the downward trend in food availability. African female farmers confront economic challenges; nonetheless, in this instance, the farmers are land managers. Findings from studies [25] demonstrate that in order to promote food security, credit needs to be improved. Additionally, [20] evaluated the need for microcredit among farmers. Limited movement, skill development, and information comprise the remaining elements. Researchers advise that in order to ensure food security for households, female farmers engage actively in agriculture.

Additionally, this article addresses the coping strategies used by different kinds of female farmers, including

farm laborers, farmers who cultivate the land, and farmers who own the land. The three make various amounts of money in the agricultural industry, where laborers pay less than farmers who own their land and cultivators. Coping mechanisms have been the subject of previous studies conducted on households in southern Ethiopia [2] and on female refugees and asylum seekers in Durban, South Africa [7]. Strengthening internal (household) strategies was prioritized in both African studies. In the meantime, the unique features of rural culture also influence the conversation in this study about the value of interpersonal support and the tendency to lend a hand to others, as well as the government's role in encouraging farmers to establish female farming organizations and offering social services and counseling to lessen poverty and financial hardships for these female farmers.

Data and methods
Collecting data
The research method uses mixed methods, starting with a quantitative approach and continuing with a qualitative approach. The research was conducted in August 2022 in the West Sleman district, especially in the Gamping and Godean sub-districts. The selection of the two districts was due to several reasons, including the proportion of females is more significant than the male population (51%), whereas, in the Gamping sub-district, the number of males is 36,747 compared to the number of females 37,611. Likewise, in the Godean sub-district, the number of females predominates, totaling 28,304 people compared to 27,617 people [26]. Furthermore, with many females, only a few worked in the agricultural sector compared to other sub-districts, namely the Gamping sub-district, as many as 460 people and in the Godean sub-district, 429 people. Most of the females in the two regions work in the household. The last reason is that these two sub-districts, including the West Sleman region, often experience tornadoes, wind rains, and long dry spells. These three forms of natural disasters can disrupt agricultural production and ultimately increase the risk of food insecurity for female farmers. Sampling using purposive sampling amounted to 52 respondents. The limited number of respondents is due to the relatively small number of active female farmers in the two regions and the assumption of sample homogeneity. This research is more of a case study in two areas (Gamping and Godean), which aims to provide an overview of female farmers' experiences and challenges in the village. To strengthen the results of this study, we added interviews using open questions aimed at understanding more deeply the working conditions of female farmers and the experience of female farmers' difficulties in accessing food.

The first step is to provide structured questions following the rules of the FIES (Food Insecurity Experience Scale) [27] to understand the food insecurity experiences of female farmers. In addition, the data collected are in the form of financial capacity (assets, income from agriculture, and side jobs), the ability of farmers to manage food and non-food expenditures, and social assistance from the government. In the second stage, the researchers conducted interviews with each female farmer in the form of questions to dig deeper into the strategies of female farmers in dealing with difficulties in accessing food, such as whether farmers use their yards to grow crops and whether farmers seek additional work to anticipate decreased income due to crop failure. Quantitative and qualitative data (categorical data) are shown in Table 1.

First data analysis: the Rasch model for determining the level of food insecurity of female farmers
FIES is a measure of individual or household food insecurity initiated by FAO using a food access approach. In 2013, FAO through the Voices of Hungry Project (VoH-FAO) study produced a scale measurement of experience of food insecurity (FIES) [27]. Food security is achieved with the characteristics of providing physical, economic, and social access to adequate, nutritious, and diverse food. In Indonesia, these rules are contained in Law No. 18 of 2012 concerning food where food security is the fulfillment of sufficient, diverse, nutritious food that reaches all people. The FIES instrument is an accumulation of two validated experience-based food security scales [27]. FIES data collection was carried out by the Gallup World Poll (GWP) from 2014 to 2016 in 153 countries that produced the FIES global reference scale [28]. [28] went on to state that the FIES is the only way to measure household or individual food security that allows for global comparability and the capacity to calibrate it against international reference standards. Since 2017 there have been nine countries that have started using FIES items in conducting surveys. Indonesia has implemented the FIES instrument in the household socio-economic survey (SUSENAS) since 2017. In this study, data on female farmers' experience of food insecurity were collected directly.

Internal analysis of FIES measurements uses the Rasch Model (RM) intended to ensure the resulting parameter estimators are in accordance with the theoretical constructs of food insecurity. RM is a psychometric model of item response theory (IRT) which is also called a one-parameter logistic model. The purpose of RM is to assess the suitability of a set of items with the theoretical constructs that underlie the measurement, construct item scales, and compare scale performance in various

Table 1 Data and variables

Symbol	Name of variable	Detail information	Unit
FI	Food insecurity	0 = food secure 1 = mild food insecurity 2 = moderate food insecurity	Ordinal
MA	Movable-assets	Assets in the form of tractors, pumping machines	IDR (million)
HHES	HH and entertainment supplies	Equipment and entertainment assets (TV, refrigerator, cell phone, household furniture, washing machine)	IDR (million)
HA	Home assets	0 ≤ 100 IDR millions 1 = 100–500 IDR millions 2 = 500–1000 IDR millions 3 = 1000–1500 IDR millions 4 ≥ 1500 IDR millions	Ordinal
AI	Agricultural income	0 = 0–500 IDR thousands 1 = 500–1000 IDR thousands 2 = 1000–2000 IDR thousands 3 = 2000–3000 IDR thousands 4 ≥ 3000 IDR thousands	Ordinal
AY	Advantage of yard	0 = not using the yard 1 = using the yard	Nominal
EF	Expenditure of food	0 ≤ 500 IDR thousands 1 = 500–1000 IDR thousands 2 = 1000–1500 IDR thousands 3 = 1500–2000 IDR thousands 4 = > 2000 IDR thousands	Ordinal
ENF	Expenditure of non-food	0 ≤ 500 IDR thousands 1 = 500–1000 IDR thousands 2 = 1000–1500 IDR thousands 3 = 1500–2000 IDR thousands	Ordinal
GA	Government assistance	0 = No government assistance 1 = With government assistance	Nominal
SJ	Side job	0 = Not doing a side job 1 = Doing a side job	Nominal

populations [27]. Rasch can show the opportunity for respondents with certain abilities (b_h) to respond correctly to questions with a certain level of difficulty (a_i) explained by the equation $\mathrm{Prob}\big(x_{h,i} = 1|b_h, a_i\big) = \frac{e^{b_h - a_i}}{1 + e^{b_h - a_i}}$. Parameter *a* reflects the severity or difficulty associated with the experience captured by the different questions, while parameter *b* measures the level of food insecurity experienced by female farmers. The probability of confirming any item by each respondent is assumed to be independent from the probability of other items by the same respondent or from the probability of the same item by other respondents. Determination of the level of food insecurity based on global standards is divided into two thresholds, namely the severity value in question no. 5 or ATELESS (the condition of eating "less than it should") and question no. 8 or WHLDAY ("lost all day without eating"). In this case, ATELESS defines the boundary between food security and moderate food insecurity whereas WHLDAY defines the boundary between moderate and severe food insecurity. So that in the end female farmers can be classified into three categories of

food insecurity levels, namely food security and mild food insecurity, moderate and severe food insecurity, and severe food insecurity [29].

Analysis of the internal validity of FIES items by looking at the value of fit statistics

The validity test is important to measure the validity of FIES items by looking at data consistency with the assumptions of the Rasch model. If the assumptions are met, the FIES measurement can be used to calculate the prevalence of food insecurity. Fit statistics show the strength and consistency of the association of each item with the underlying latent properties [30]. Furthermore, the FIES item scale in Sleman was calibrated with a global reference scale [28, 29].

Item suitability is intended to see the accuracy of items with the Rasch model. There are three criteria used to see the level of item fit, they are *outfit means-square* (MNSQ), *outfit z-standard* (ZSTD), and *point measure correlation* (PTMC) [31, 32]. The standard value of item suitability criteria, where the MNSQ outfit score ranged from more than 0.5 to less than 1.5 [33]. For the Outfit

ZSTD, criteria the standard value is between -2.0 to less than 2.0, and the criterion value for PTMC ranges from 0.4 to less than 0.85. If the three criteria are met in the item, the item is considered "appropriate" or valid and it can be ascertained that the quality of the item is good and usable. However, if only two criteria or one criterion can be met, then the item can still be maintained, and the item does not need to be changed. It is concluded that as long as the item meets one of the three criteria, the item is categorized as "appropriate" and usable.

After all the question items meet the validity and reliability requirements, measure the prevalence of respondents' food insecurity based on "classes" determined according to international standard thresholds [28]. Two global standard thresholds sets for the severity of the two FIES items, namely ATELESS (item fifth) and WHLDAY (item eighth). Each class defines moderate and severe food insecurity class limits. The amount of the threshold value follows the formulation in the Excel form provided by FAO in two indicators, namely, FImod + sev (proportion of the population experiencing moderate or severe food insecurity) and FIsev (proportion of the population experiencing severe food insecurity) [28]. In addition, respondents (women farmers) were evaluated based on their raw score and then probabilistically assigned to one of two food insecurity classes. If the individual respondent's probabilistic raw score exceeds the FImod + sev limit, they categorize as "moderate food insecure". If lower, they categorize as "slight food insecure". In this study, we divided into four groups: the class not experiencing food insecurity, the class experiencing mild food insecurity, the class experiencing moderate food insecurity, and the class experiencing severe food.

Based on Fig. 1, four classes categorize the degree of food insecurity that female farmers suffer. Due to the limited **52** respondent population and the need for more diverse data, we separated the mild food insecurity class categories from the safe food class categories in this study. The traits of female farmers who occasionally suffer light food insecurity differ from those of female farmers who have never encountered it, which brings us to our next point. In other words, farmers who have never faced food insecurity scored 0 for each of the eight questions.

Second data analysis: ordinal logistic regression model

Ordinal logistic regression analysis is then performed to calculate the probability of food insecurity for female farmers depending on their traits and the mitigation strategies they adopt. FIES external analysis, where the dependent variable displays the degree of food insecurity and its determinants, which in this case are connected to economic access and include asset ownership, income from agricultural activities, spending on food and non-food items, and side jobs held by people who are not farmers. The availability of social aid from the government explains the level of food insecurity experienced by farmers. Physical access is accounted for by using the yard for household needs like food production. Three factors determine whether a female farmer experiences food insecurity. The logistic regression model is then explained in two logit regression models, namely

$$Logit\ 1[P(Y_i \leq 1|x_i)] = \ln\left[\frac{P(Y_i \leq 1|x_i)}{1 - P(Y_i \leq 1|x_i)}\right] = \beta_{01} + x_i^T\beta. \tag{1}$$

In this logistic regression model 1, the probability of category 1 (non-food insecure status) can be calculated as follows:

$$\pi_1(x) = P(Y_i \leq 1|x) = \frac{\exp(\beta_{01} + x_i^T\beta)}{1 + \exp(\beta_{01} + x_i^T\beta)}. \tag{2}$$

Furthermore, the category 2 logistic regression model (mild food insecurity status) is shown in Eq. 3 and the chance of female farmers experiencing light food insecurity is represented in Eq. 4:

$$Logit\ 2[P(Y_i \leq 2|x_i)] = \ln\left[\frac{P(Y_i \leq 2|x_i)}{1 - P(Y_i \leq 2|x_i)}\right] = \beta_{02} + x_i^T\beta, \tag{3}$$

$$\begin{aligned} \pi_2(x) &= P(Y_i \leq 2|x) - \pi_1(x) \\ &= \frac{\exp(\beta_{02} + x_i^T\beta)}{1 + \exp(\beta_{02} + x_i^T\beta)} - \frac{\exp(\beta_{01} + x_i^T\beta)}{1 + \exp(\beta_{01} + x_i^T\beta)}. \end{aligned} \tag{4}$$
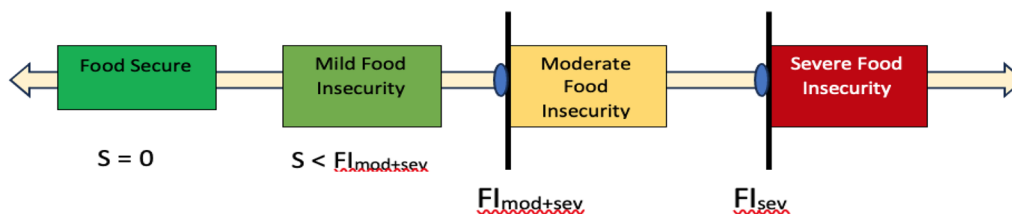
Fig. 1 Food insecurity prevalence rates. **Note:** S is the respondent's raw score measured probabilistically following the Rasch model [29]

To determine the opportunities for female farmers who experience moderate food insecurity can be calculated as follows:

$$\pi_3(x) = 1 - P(Y_i \leq 2) = 1 - \frac{\exp(\beta_{02} + x_i^T \beta)}{1 + \exp(\beta_{02} + x_i^T \beta)}. \tag{5}$$

Logit $Logit\left[P\left(Y \leq j | x_i\right)\right]$ is the cumulative probability of events $(Y_i \leq j)$, where j is the number of categories of 3 food insecurity occurrences (1: no food insecurity, 2: mild food insecurity, and 3: moderate food insecurity). β_{0j} is an intercept parameter known to satisfy the condition $\beta_{01} \leq \beta_{02} \leq \beta_{0j} - 1$ dan $\beta = \left[\beta_1 \beta_1 \ldots \beta_p\right]^T$ is an unknown regression coefficient vector and corresponds to x_i. Based on Table 2, it is explained that the level of food insecurity functions as the dependent variable while the independent variables used represent a proxy for physical access (home yard used for food crops), social access (assistance provided by the government), and economic access (asset ownership, food expenditure, non-food expenditure, income from farmer work and extra income).

Results and discussion

Profile of female farmers

Most females working as farmers in Sleman are laborers: 24 people (42.3%), 19 women who own agricultural land (40.4%), and only nine or 17.3% of females who rent agricultural land. The low ability to rent agricultural land is caused by the additional burden of capital and the need to employ labor farmers, meaning that few have this ability. Related to ability can be represented by cognitive abilities through female farmers' education level. The interviews with female farmers with laborer status show that most do not go to school or do not finish school at the elementary level (50%), while some only finish elementary school at grade 3 and some up to level 5. Not only laborers with primary education, but about 9.5% of

landowners still need to finish school at the elementary level. This number is small, which means that female farmers with low education can manage finances, work hard, add non-formal education (agricultural training), and manage their agricultural land. They act as owners as well as farm laborers. In general, landowners with a high school education (high school) with 12 years of schooling are 47.6%. Uniquely, there are landowners with higher education (graduates), although the number is tiny at 4.8%. The various educational backgrounds of landowners indicate that the agricultural sector is in demand by all backgrounds. The next group, namely land tenants who primarily educate, is the most numerous compared to laborers and landowners at the high school education level (high school), 55.6%. However, land tenants with elementary and junior high education are quite balanced at 22.2%. To improve their agricultural skills, some land-interfering farmers attended training on crops such as chili and how to process crop yields.

One intriguing aspect of female farming in the Gamping and Godean—Sleman sub-district is that up to 50% of farm laborers are elderly, mostly in their 60s and 70s. Despite being older, the person is still enthusiastic about working in the rice fields. This reality is inextricably linked to the widow status, as it motivates them to work as farm laborers to make ends meet by living alone or with other families (grandchildren, sisters, or children). In addition, a sizable portion of female farm workers—36.4%—between the ages of 45 and 60 are comparatively more vigorous and productive than older people. They may decide to work as farm laborers for various reasons, such as to help their husbands out financially or to make farming their full-time occupation. Furthermore, the average family size of laborers is four, which is higher than that of landowners and tenants. It puts more pressure on female workers to work long hours in the agricultural sector regardless of age. Only two of 22 female farmers saw farm labor as extra

Table 2 The FIES questionnaire asks for the respondent's experience in the past 12 months. Sources: (Ballard et.al. [27])

Symbol	Scale item	FI severity assumptions
WORRIED	Felt anxiety about having enough food at any time during the previous 12 months	Mild
HEALTHY	Not able to eat healthy and nutritious food because of a lack of money or other resources to get food	Mild
FEWFOOD	Consumed a diet based on only a few kinds of foods because of a lack of money or other resources to get food	Mild
SKIPPED	Did not eat breakfast, lunch, or dinner (or skipped a meal) because there was not enough money or other resources to get food	Moderate
ATELESS	Ate less than you though they should because of a lack of money or other resources to get food	Moderate
RUNOUT	Household ran out of food because of a lack of money or other resources to get food	Moderate
HUNGRY	Felt hungry but did not eat because there was not enough money or other resources for food	Severe
WHLDAY	Went without eating for a whole day because of a lack of money or other resources	Severe

work. On the other hand, most female landowners and tenant farmers work in industries other than agriculture, such as MSME trading, selling salt, buying grain, and setting up shop to provide jobs in the laundry services industry.

Landowners cultivate up to 70% of the most prevalent varieties of rice plants; the remaining varieties include chile, almonds, and other plants. The same holds for female land tenant farmers whose main crop is rice. In Sleman district, rice is primarily cultivated in three seasons: during the rainy season, during the dry season (when irrigation is unavailable and rainwater or using a rainfed), and during the dry season. That means the cropping pattern in the Sleman district is primarily paddy–paddy (70%). Less than 9% of female farmers with landowner or tenant status utilize the rice–corn–rice growing pattern (Fig. 2).

Landowner farmers produce much rice, but only a portion is sold on the market. Family use accounts for 28% of the overall rice production. In contrast to land-tenant farmers selling up to 81.5% of their rice plants to the market, they consume the remaining 18.5% for their own consumption. Since agriculture is the primary source of revenue, selling agricultural products to land tenant farmers should be the top focus. Unlike landowners, who get their living from other sources, such as grocery stores and launderettes, there are various kinds of companies. Landowners also profit from leasing their properties to tenant farmers. Therefore, the burden on land renter farmers differs more than landowner farmers. According to the data above, female farmers mainly operate in agriculture as a source of household food and revenue. Developing nations like South Africa, which rely heavily on agriculture and generate 70% of the region's food, are particularly prone to this problem [34]. Food insecurity in South Africa results from the government's failure to invest in female farmers, as per

[35], which means that the government should prioritize female's role in agriculture.

Female farmers in managing food and non-food expenditures

Farmers' food consumption habits are not affected by their revenue source. The value of farmers' agricultural income is minimal when you look at it. Labor farmers, for instance, may make less than IDR 500,000 per month. Only one labor farmer claims to make between IDR 1 million and IDR 2 million per month, while another 27% make less than IDR 1 million. The monthly income of 68% of employed female farmers is less than IDR 500,000. Due to their limited resources, labor farmers must rely only on selling food they produce in the market or working with their yards and agricultural products. On the other hand, 52.4% of female landowner farmers make between 500 thousand and one million rupiah annually. Furthermore, 19% of the population makes between IDR one and two million from agriculture. It also holds for female land-renting farmers, the majority of whom make between IDR 500 and 1 million, or 44.4% of the average national income. However, land tenant farmers earn between IDR 1 and 2 million annually and earn 33.3% more than landowners. Tenants and landowners often make between IDR 500 and 1 million a year. Of course, this excludes the agriculture sector; it does not include revenue from other sources.

We must first comprehend female farmers' spending habits on food and non-food goods to determine the extent of food insecurity among them. Based on total expenditure, Table 3 shows 7 (seven) commodities of food expenditure, and Table 4 shows 12 (twelve) types of non-food expenditure for female farmers. Compared to landowners and tenants, laborers have a different pattern of food expenditures; most of their less than IDR 500 thousand expenditures go towards purchasing nuts, veggies, and spices. Meanwhile, land tenants and landowners spend more on buying vegetables and beans. It is related to the culture of the local people, who are used to eating vegetables as a priority. The price is relatively cheaper than side dishes such as fish and meat. There are similarities in behavior between laborers, landowners, and land tenants who do not consume cigarettes. The main factor is limited spending, less than IDR 500 thousand, which is only enough to buy necessities. However, when the amount spent on food climbed, so did the amount that female farm labourers spent on cigarettes; this went from 8.23% when the total amount spent was between IDR 500 thousand and IDR 1 million to 51.35% when the amount spent exceeded IDR 1.5 million. In this instance, the primary cause of the anxiety associated with food expenses

Production (Land Owners)
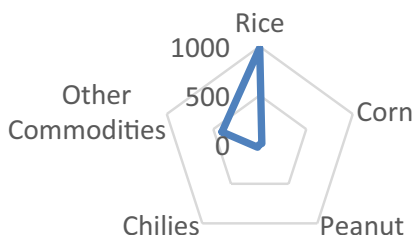
Fig. 2 Types of crops produced by landlord farmers. **Note:** Calculated from survey results

Table 3 Variety of food expenditure of female farmers (%). Source: Frequency data are calculated from survey results

Expenditure (IDR. thousand)	Percentage (%)	Grains and tubers	Fish and meat	Eggs and milk	Vegetable and nuts	Fruits	Herbs	Processed food drink	Cigarette
Laborers									
< 500	9.1	15.44	13.29	18.01	23.56	0.00	25.66	4.04	0.00
500–1000	59.1	20.15	13.31	9.47	18.28	2.21	17.16	11.17	8.23
1000–1500	27.3	22.03	9.10	7.34	14.21	7.28	11.17	18.32	10.55
> 1500	4.5	21.03	5.14	3.70	8.95	1.47	4.70	3.67	51.35
Land tenant									
< 500	14.3	11.16	9.52	8.47	37.72	7.92	23.92	1.30	0.00
500–1000	47.6	22.71	9.38	8.82	24.03	4.10	14.68	6.65	9.63
1000–1500	33.3	18.84	12.12	6.66	24.77	7.82	7.55	12.84	9.40
> 1500	4.8	9.19	9.46	5.95	47.04	12.44	4.76	11.16	0.00
Landowners`									
< 500	22.2	1.64	6.59	6.54	57.77	3.99	12.76	10.71	0.00
500–1000	66.7	21.37	9.47	9.30	26.84	2.67	12.10	6.91	11.34
1000–1500	11.1	7.78	41.95	6.50	28.69	0.00	4.80	5.55	4.74

is tobacco use among family members of female farmers, particularly the spouses of these farmers. Grain and tuber products rank second.

The most significant expenses for female farmers as laborers, landowners, and land tenants ranged from IDR 500 thousand to one million, amounting to 59.1% for laborers, 47.6% for land tenants, and 66.7% for landowners. Grains and tubers are the most preferred commodities, which burden female farmers, especially labor farmers. Food commodities that require significant expenditure for land-owning farmers and land tenants are vegetables and nuts, fish and meat, fruits, and processed food and beverages. Expenditure on these commodities increases along with the high food expenditure land tenants and landowners face. On the other hand, meat and fish consumption rises while fruit consumption falls with increasing expense, particularly for landowners. Diverse dietary patterns reflect varying degrees of farmer desire. Landowners and tenants' spending patterns on cigarettes are intriguing, as neither group smokes when their food expenses exceed IDR 1.5 million or IDR 1 million. When food costs rise, they are more likely to try to satisfy their dietary requirements.

Twelve non-food spending items are necessary for female farmers. Table 4 illustrates the overall amount of non-food spending and indicates that, across all spending levels, electricity is the largest category. Surprisingly, expenditure on social and religious activities comes first for labor farmers and land tenants, followed by electricity. They will fortify kinship links through religious activities, emphasizing the preservation of local communities' social relations. For land-owning farmers,

non-food expenditure increases in line with increasing expenditure on education, likewise for laboring farmers and land cultivators who provide an increasingly large portion when the non-food expenditure allocation increases. It shows how important the role of females is in improving the quality of their family's human resources through educational awareness.

Data description of food insecurity experience of female farmers

The answer "YES" to each question indicates that the respondent has experienced food insecurity using FIES. The FIES items list various scenarios according to the severity of food insecurity faced by women farmers. According to [27], when we move towards point 8, the issue of food insecurity becomes more severe. According to [36], the percentage of each question item should decrease from point one to point eight—the percentage of female farmers who chose "YES" for each FIES question in Fig. 3. More respondents selected the FEWFOOD item (eating only a few different types of food) than the HEALTH item (being unable to eat nutritious and healthful food). If the respondent reports food insecurity on a more serious question, the preceding, less severe question item also received a "YES" response, suggesting that there may be a discrepancy in the responses. Eight percent of respondents said they have never been exposed to healthy and harmful foods but have never eaten little.

The fact that most female farmers are elderly makes their experience with food insecurity particularly unique. As a result, dietary limitations—the practice of only eating a limited variety of foods—are a typical occurrence. A few

Table 4 Variety of non-food expenditure of female farmers (%). Source: Processed from survey results

Expenditure (IDR. thousand)	Percentage (%)	Tax and property tax	Electricity	Household expenditure (oil, wood, gas)	Telecommunication/ Internet	Water	Oil fuel (gasoline and transportation)	Esthetic consumption	Education	Health	Clothing	Durable goods (kitchen, house appliances)	Religious social activity
Laborers													
<500	40.9	2.00	23.71	14.16	7.51	2.10	6.51	18.34	0.00	7.63	0.00	0.00	18.04
500–1000	40.9	1.34	15.25	8.17	11.39	0.00	16.59	15.34	2.98	10.79	1.43	0.00	16.71
1000–1500	18.2	0.26	10.74	4.72	16.87	1.79	23.59	7.14	14.45	1.42	1.45	0.00	17.59
Land tenant													
<500	27.3	2.90	27.78	16.64	1.11	3.95	2.21	20.86	0.00	4.28	1.04	0.00	19.24
500–1000	40.9	1.49	18.65	9.92	1.63	0.00	21.10	14.42	0.00	12.24	0.00	1.30	19.26
1000–1500	18.2	1.70	10.68	6.22	13.28	0.00	18.49	6.04	16.29	2.47	4.72	0.29	19.82
>1500	9.1	1.76	5.09	4.43	8.26	0.00	11.92	5.67	41.28	0.00	5.52	2.41	13.67
Landowner													
<500	55.6	2.07	32.31	19.25	0.00	0.00	8.66	19.15	0.00	2.24	0.00	0.00	16.31
500–1000	33.3	3.16	23.44	10.35	0.00	0.00	4.71	10.72	36.07	2.13	2.70	0.00	6.73
>1500	11.1	2.43	2.91	5.12	5.82	0.00	8.73	6.58	65.98	0.00	0.00	0.00	2.43

Fig. 3 Proportion of female farmers answering "Yes" to experienced food insecurity. **Note:** Calculated from survey results

female farmers also have to deal with the expense of simultaneously eating healthful food. It alludes to the dietary habits of women farmers, who tend to eat a lot of grains and vegetables but not as much of other healthful items like milk, meat, or fish. Apart from being financially incapacitated, the food culture factor in the Java region also influences the commodities consumed by female farmers (the staple food is rice supplemented with vegetables and a side dish of tempeh-tofu). The fifth item (ATELESS) also shows experiences considered like the third question item (FEWFOOD) by female farmers. However, female farmers experience less difference compared to eating certain types of food. The eight FIES questions conclude that the most significant percentage of female farmers who inconsistently answered the FEWFOOD items (8%) and ATELESS was 4%. However, both can still be used to measure women farmers' food insecurity level due to their unique experience of food insecurity, as explained above.

The severity scale of FIES items with global standards
The severity scale shows the negative impact on the households of female farmers due to their inability to access the food they need [28]. Next, statistical fit, which consists of infit and outfit, shows the strength and

consistency of each question item with its latent nature [37]. This statistical fit test also explains the instrument's validity (one-dimensionality of the instrument), which evaluates whether the instrument (question items) used can measure what should be measured so that it can be said to be valid. Table 5 displays the results of measuring the item severity scale and statistical fit. The reliability test for each question item using Cronbach Alpha showed a value of 0.86, meaning that the interaction between the person and the item proved reliable.

The results of the validity of the eight questions meet the criteria for validity requirements, except question number 2 (HEALTHY) meets one criterion to be declared a fit or valid item. So, it meets the PTMC criteria but does not meet the Outfit MNSQ and ZSTD criteria. Question number 2 (WORRIED) fulfills two criteria. The rest of the questions meet all three validity criteria. The calibration item with a global reference scale shows a value between -2 and 2. A scale close to -2 indicates an item that is easy for the respondent, while an item severity scale close to 2 indicates that the item is complicated for the respondent [38] in [36]. The calibration results show that all question items are in the accepted reference range and follow the FIES item's theoretical construct. Only the eighth question item (WHLDAY) has a value slightly exceeding 2, which means that the question item is considered quite tricky by farmers. In addition, according to [36], the value in the global scale difference column with the Sleman scale, which is more than 0.35, indicates that the question item is a unique item because it is understood differently by female farmers, the unique questions are items number 4 (SKIPPED), 5 (ATELESS), 6 (RUNOUT) and 7 (HUNGRY).

The level of food insecurity of female farmers in rural areas—West Sleman, Indonesia
Measuring the level of food insecurity of female farmers using FIES with the Rasch model shows that most female

Table 5 Parameters of FIES item severity scale of female farmers in rural areas—West Sleman and fit statistics. Information: Processed from Winstep output

Item	Global Item Severity Scale	Sleman Item Severity Scale	Sleman Severity Scale (calibrated with Global Scale)	The difference between the Global Scale and the Sleman Scale	Outfit MNSQ	Outfit ZSTD	PT-MEASURE CORR
Worried	− 1.223	− 1.1	− **1.44**	0.34	1.61	1.8	0.66
Healthy	− 0.847	− 0.83	− **0.99**	0.17	2.04	3.1	0.7
Fewfood	− 1.106	− 1.98	− **1.3**	0.68	0.74	− 0.5	0.83
Skipped	0.351	0.29	**0.42**	0.13	1	0.1	0.71
Ateless	− 0.312	− 0.29	− **0.36**	0.08	0.9	− 0.3	0.74
Runout	0.507	1.31	**0.6**	0.71	0.74	− 0.6	0.7
Hungry	0.755	1.31	**0.89**	0.42	0.53	− 1.1	0.68
Whlday	1.876	1.31	**2.21**	0.91	0.64	− 0.2	0.58

farmers as laborers, land owners, and land tenants are in the food secure category. Even though the percentage of food insecure workers is lower than land owners and cultivators. In contrast, the percentage of workers experiencing moderate and severe food insecurity is 23% higher than that of land owners (14%), and the number of land cultivators is the lowest (11%).

More farmer laborers experience mild and moderate food insecurity than landowners and tenants, indicating a financial inability to access food. It naturally occurs considering the average income of laborers is less than IDR 500 thousand, which is lower than that of landowners and tenants. The experience of food insecurity experienced by land tenants is unique because, on the one hand, they experience moderate and severe food insecurity, which is the lowest compared to laborers and landowners. However, many land tenant farmers experience 22% light food insecurity compared to 19% of landowners. It means that land tenants are more likely to experience consuming fewer types of food, while landowners are more experienced in consuming less and even skipping meals. Previous research at the macro-level explained the same findings as this study. Namely, women in low- and middle-income countries are vulnerable to experiencing food insecurity [39]. The difference is that the research in Godean and Gamping raises deep issues related to women who live in rural areas and work as farmers. Two topics are often carried out separately by previous researchers, namely the focus on women living in rural areas [40] or the focus on rural farmers [41] and [42]. Anjali's findings explain that older women living in rural areas (over 50 years) are more prone to experiencing moderate and severe food insecurity than men. Research results on female farmers in Godean and Gamping correct the findings of [40], where the women who work in the agricultural sector are primarily elderly (over 50 years old) and are not necessarily vulnerable to experiencing food insecurity, as shown in Table 6.

Other researchers focusing on rural farmers [41] mention farmers as the most influential actors in food security in Nigeria. So that agricultural policies need to target farmers to get out of the problem of food insecurity. Jacob's research emphasizes the importance of paying attention to farmers' food insecurity conditions but has yet to explain the characteristics of farmers who need to prioritize. The research findings in Godean and Gamping answer Jacob's research gap, where labor farmers and land tenants need primary attention because they are more vulnerable to experiencing moderate and severe food insecurity than landowners. These results align with [42] on farmers in India, where farmers who do not own land are ten times more likely to be without food than large farmers, with a ratio of 18% to 12%. In this respect, landless farmers are similar to labor farmers in Godean and Gamping. Unfortunately, Jaacks' research only used three questions from the standard, which allows FIES as many as eight questions. In addition, three-point questions ask within the last month (period of COVID-19). Even though according to FAO standards, FIES questions get individual experience in the past year. So that the results obtained by Jaacks are limited to descriptive data in the form of the percentage of farmers who are worried that they will run out of food if the farmer answers question number 1. Likewise, with the data for the second question (skipping meals) and the third question (without eating all day). Another exciting finding explains that labor farmers, tenants, and landowners are experiencing moderate and severe food insecurity, although the percentages differ. Exploring more deeply the similarity of the characteristics of the three shows that farmers who are vulnerable to food insecurity are farmers who have low education (do not graduate from elementary school to elementary school), have a large number of dependents (4 to 7 people) consisting of children, grandchildren, in-laws to younger siblings. The research results on female farmers in Godean and Gamping align with the findings of [43] on women in the European Region.

Determinants of the level of food insecurity among female farmers in rural areas—West Sleman

The results of ordinal logistic regression show the influence of external factors on the tendency of female farmers to experience food insecurity (Table 7). Ownership of movable assets such as tractors and pumps has a positive but insignificant effect on the likelihood of moderate and severe levels of food insecurity. Likewise, household equipment and entertainment assets consisting of TVs, refrigerators, cell phones, household appliances, and washing machines also do not significantly affect the probability of moderate and severe food insecurity for female farmers. Both results refer to the Wald test value.

Table 7 shows two constant values for the threshold (FI = 0 and FI = 1). Three dependent variables, or response variables, are present, causing a difference in

Table 6 Level of food insecurity of female farmers by group. Source: Frequency data are calculated from survey results

Group	Food secure (%)	Mild food insecurity (%)	Moderate food insecurity (%)
Laborers	50	27	23
Landowner	67	19	14
Land Tenant	67	22	11

Table 7 Ordinal logistics model of the level of food insecurity in female farmers in Sleman Sources: output SPSS 23. * Sig 10%, ** Sig 5%, *** Sig 1%

Variable	Estimate	Wald test
Threshold [FI=0]	16.106	9.818***
Threshold [FI=1]	18.814	12.972***
Movable-assets	3.37E−08	1.556
HH and entertainment supplies	2.86E−08	0.049
Home assets (<IDR.100 million)	10.748	15.737***
Home assets (IDR.100-500 million)	7.833	12.680***
AgricIncome (< IDR. 500 thousand)	17.482	48.434***
AgricIncome (IDR. 500thousand- IDR. 1 million)	18.209	67.166***
Advantage of Yard (=0)	2.957	4.029**
Expend-Food (IDR. 500 thousand- IDR.1 million)	− 17.725	55.515***
Expend-Food (IDR. 1 million- IDR.1,5 million)	− 15.779	36.938***
Expend-NonFood (<IDR. 500 thousand)	− 19.761	149.451***
Gov-assistance(=0)	− 3.576	5.833**
SideJob (=0)	− 6	5.949**
Name of test	Chi-square	
Model fitting: final	49.690***	
Goodness of fit		
Pearson	86.651	
Deviance	49.144	
Pseudo R-square		
Nagelkerke	0.724	

the value of this constant, resulting in the following two logit models;

Logit [FI=0] = 16,106 + 3,37E-08Movable-Assets + 2,86E-08 HH and Entertainment Supplies + 10,748 Home Assets (< IDR. 100 million) + 7,833 Home Assets (IDR. 100-500 million) + 17,482 AgricIncome (<IDR.500 thousand)+ 18,209 AgricIncome (IDR.500thousand-IDR. 1 million) + 2,957 Advantage of Yard(=0)−17,725 Expend-Food (IDR.500 thousand-IDR. 1 million)−15,779 Expend-Food (IDR. 1 million-IDR. 1,5 million)-19,761 Expend-NonFood (<IDR. 500 thousand)-3,576 Gov-assistance (=0)−6 SideJob (=0)

The first logit equation expresses the likelihood that female farmers have never experienced food security or insecurity [FI=0].

Logit [FI=1] = 18,814 + 3,37E-08Movable-Assets + 2,86E-08 HH and Entertainment Supplies + 10,748 Home Assets (< IDR. 100 million) + 7,833 Home Assets (IDR. 100-500 million) + 17,482 AgricIncome (<IDR.500 thousand)+ 18,209 AgricIncome (IDR.500thousand-IDR. 1 million) + 2,957 Advantage of Yard(=0)−17,725 Expend-Food (IDR.500 thousand-IDR. 1 million)−15,779 Expend-Food (IDR. 1 million-IDR. 1,5 million)-19,761 Expend-NonFood (<IDR. 500 thousand)-3,576 Gov-assistance (=0)−6 SideJob (=0)

The second logit equation represents the likelihood of mild food insecurity for female farmers [FI=1]. The two probability values above vary depending on nine (9) independent variables. Because the Wald test showed that the nine independent variables were significant, the following paragraphs describe each independent variable's effect.

Homeownership is one of the main assets for female farmers that can strengthen food security; however, the assets of the house mentioned should be more than IDR. 500 million. Based on the results of the Wald test for house assets whose value is less than IDR 500 million, it proved to be significant. It had a positive effect on the tendency of female farmers to experience severe food insecurity. House assets are essential for female farmers to guarantee their financial ability to deal with food insecurity. However, female farmers who own low-value houses show that they are not financially strong. Moderate and severe food insecurity for female farmers occurs when the income obtained from the agricultural sector is insufficient to meet their food needs. Female farmers who tend to be at risk of experiencing moderate and severe food insecurity earn less than IDR. 1 million. Based on income data, it shows that most female farmers are laborers who earn less than IDR. 1 million, even if the average is less than IDR. 500 thousand. These results explain that female farmers who earn more significant income in the agricultural sector will increase their tendency to experience food security compared to those with less income. In this case, female farmers can buy food needs in the market if they have a higher income and vice versa.

Economic access, asset ownership, and income level show the ability of women farmers to obtain food. It implies that female farmers with greater economic access can avoid food insecurity. Conversely, individuals with low earnings and insufficient financial security are likelier to experience moderate-to-severe food insecurity. The inference is that the ability of female farmers to make ends meet determines food sufficiency in the main. Moreover, moderate-to-severe food insecurity is problematic for female farmers who do not use their yards. The Wald test results show that farmers who do not use their yards have a significance value of 4.029 (significant at the 5% significance level) for the tendency to moderate and severe food insecurity. Women farmers whose income is slightly above the poverty line in the Central Java region (Rp. 411,610) [23] cannot only rely on economic access to meet food needs, as previously explained, because women farmer families must also be able to meet non-food needs such as electricity, education, fuel needs for the kitchen, and expenses for religious and social activities. Therefore, by utilizing the closest physical access, namely the yard of the house, it

can reduce the financial burden. Culturally, rural people usually use their yards to plant chilies, vegetables, fruits, and livestock. Tumpukono, a female farmer worker who has the status of a widow, said the reason for planting chilies "is because chilies are expensive, so planting them yourself will make it easier if you want to cook, you just have to pick them in your own yard". This statement also emphasizes the importance of proximity as a proxy for physical access to meet food needs. The results of the present research are consistent with [44], who argue that the level of food insecurity in Jamaica's Blue Mountains and John Crow National Parks (BPJMNP) can be affected by the use of wild plants as a food source.

The results of the external analysis of female farmers' food insecurity also explain what factors influence the tendency of female farmers to experience mild food insecurity to food security. There are five factors statistically proven to reduce the risk of moderate and severe food insecurity, namely a minimum food expenditure of IDR 500 thousand to IDR 1 million, the allocation for non-food expenditure is less than IDR 500 thousand, not dependent on social assistance from the government, and working full time in the agricultural sector (or not having additional jobs). The portion of higher food expenditure than non-food expenditure shows that female farmers can meet their family's food needs. In this case, the ability of female farmers to prioritize food needs and then set aside as necessary for non-food needs has an impact on reducing the risk of moderate and severe food insecurity. The prioritized non-food products are expenses for electricity needs because electricity is also the primary need that supports the daily life activities of farming families. According to [45], efforts to increase food security through women's role in managing non-food spending can take advantage of local culture. In this case, the researcher explains that cultural aspects such as patriarchal norms and tradition can prevent women from controlling household income. As a result, women tend to spend less on accessing food or are more able to afford to spend. The culture described by [45] also applies to the Javanese, so the patriarchal approach can be applied to female farmers in Java (in this study in West Sleman) in reducing the risk of food insecurity.

Furthermore, since this may cause them to become less mindful of the risk of food insecurity, female farmers should avoid relying solely on government social aid. Farmers who maintain their habits by saving money will depend on government help. When asked if they had made an effort to ensure family food security, one of the female farmers who received government-funded social assistance stated as much. Married farm laborer Sarwati declared, "There are no adaptation or anticipation efforts to maintain family food security." This statement

makes sense since the social assistance female farmers receive is sufficient to estimate the risk of food insecurity. Even though they receive social assistance from the government, some farmers borrow money from neighbors or the community. Several farm workers, namely Margini and Tukiyem, who received support from BST (cash social assistance) and PKH (Family Hope Program), expressed this. Therefore, solutions that depend only on government social support cannot overcome moderate-to-severe food insecurity among female farmers.

Not having a second job is the final element impacting lowering the risk of moderate and severe food insecurity. The Wald test findings 5.949, which indicate statistical significance at the 5% level, support this. It demonstrates that more employment cannot lower the risk of moderate and severe food insecurity because the income from additional labor is negligible or higher than that of working in agriculture. Additionally, female farmers must put in much time laboring in the fields. In this scenario, female farmers must split their morning and afternoon labor hours between cleaning and the fields. It also means there needs to be more time for female farmers to allocate time for other work. Female farmers should focus on working in agriculture optimally and productively so that it will impact the productivity of crops. As a result, the output of agricultural products increases, which in turn will also impact the income of female farmers. [46] presented their findings to poor households in rural KwaZulu-Natal, South Africa, that a sociocultural approach through empowering women can reduce food insecurity. However, empowerment alone is insufficient; [46] suggested increasing physical assets through additional off-farm jobs and household agricultural production capacity in their research. The results of a study of female farmers in the villages of Gamping and Godean contrast the findings from a study conducted in KwaZulu-Natal. Consequently, female farmers must concentrate on augmenting agricultural output through efficient time management. Most Gamping and Godean female farmers are elderly (over 50), which could account for the discrepancy in the study's findings. Therefore, physical limitations prevent female farmers from obtaining employment outside of agriculture.

Coping behavior strategy for female farmers in facing family food insecurity

There are two behavioral techniques to overcome food insecurity, particularly for females, according to study findings [37], in the form of a literature review compiled in the post-2000s period, namely food-based and non-food-based coping behaviors. Reducing daily food quantities, consuming fewer overall shared meals, or choosing not to eat at all (food rationing) are behaviors people take

to avoid food-based food insecurity. Contrarily, non-food-based coping strategies include altering one's livelihood (or finding a career outside the home), selling property, borrowing money and food, and other possibilities to buy food on credit. The following paragraphs discuss strategies for helping female farmers in Godean and Gamping communities overcome food insecurity. In addition to coping techniques that rely on the skills of female farmers, social capital and government support are also suggested as external remedies to combat food insecurity.

The first is using behavioral coping strategies for dealing with food-based food insecurity. In the rural areas of Gamping and Godean, female farmers reduce food insecurity by putting money aside for non-essential items. In other words, spending is more likely to be used to purchase food or other necessities. However, according to [2], consuming inexpensive and unusual meals can lower the likelihood of experiencing food insecurity. Empirical findings (Table 7) illustrate how female farmers must allocate more spending on food than non-food to reduce the risk of food insecurity and support coping behavior. We then determined the number of female farmers likely to avoid moderate food insecurity based on the food-related coping strategies displayed in Table 8. The data illustrate the percentage of female farmers in the group based on their spending habits for food and non-food items.

According to calculation results, 88.8% of female farmers who own land have the most robust ability to manage food expenses between IDR 500 thousand and more than IDR 1.5 million, followed by 86.4% of farmers working on farms and 80.9% tenant land. Most land-owning farmers can reduce their probability of experiencing moderate food insecurity by prioritizing food purchases in their food-based coping strategies. Their ability was also strengthened by 55.6% of land-owning farmers only budgeted less than IDR 500 thousand in non-food

expenditures. On the other hand, 59.1% of farm laborers and landowners prefer to budget non-food expenses of between IDR 500 thousand and IDR 1.5 million. These findings suggest that the behavior of female farmers' coping strategies varies. Landowner farmers can prioritize food purchases and save money more than farm laborers and cultivators. The probability that laborers and land tenants would experience moderate food insecurity will rise if they cannot reduce non-food expenditures. This conclusion assumes ceteris paribus, which assumes that the influence of other factors remains constant. The coping strategy used by Godean and Gamping's female farmers is comparable to Bangladeshi women's and children's decision to reduce their food intake [47].

Furthermore, when efforts to encourage frugal behavior no longer reduce household food insecurity, landowners and farmers who rent land borrow money to pay for their needs and business. Laborers prefer to ask their friends and family for free meals or cash. Given their situation as laborers with meager and erratic wages, appealing for assistance is feasible. The non-food-based coping mechanism is one of the actions taken by female farmers, such as asking for help or indebtedness to other people. For women farmers in the villages of Gamping and Godean, the advice [48] that advocates obtaining employment outside of agriculture is inappropriate. This conclusion supports the empirical findings (Table 7), demonstrating how female farmers without other jobs can lower their risk of moderate food insecurity. The findings of [48] differ from those of Gamping and Godean's female farmers primarily because they are older and more likely to be agricultural laborers, two characteristics that are constraints.

Table 9 provides additional information for the analysis of coping mechanisms that are not food-based. Labor farmers are less likely to experience moderate food insecurity since they devote 79.2% of their time to farming. Up to 88.9% of land tenant farmers have additional jobs,

Table 8 Percentage of probability of female farmers reducing the incidence of moderate food insecurity through food and food-based coping strategies. Source: Data processed from survey results

Farmer type	Food expenditure (IDR. thousand)				Non-food expenditure (IDR. thousand)			
	Decreasing the probability of moderate food insecurity		Increasing the probability of moderate food insecurity		Decreasing the probability of moderate food insecurity	Increasing the probability of moderate food insecurity		
	IDR 500 -IDR.1000	IDR. 1000- IDR.1500	< IDR.500	> IDR. 1500	< IDR. 500	IDR. 500–1000	IDR. 1000–1500	> IDR. 1500
Laborers	59.1	27.3	9.1	4.5	40.9	40.9	18.2	
Land tenant	47.6	33.3	14.3	4.8	27.3	40.9	18.2	9.1
Landowners	66.7	11.1	22.2		55.6	33.3		11.1

Table 9 Percentage of probability of female farmers reducing the incidence of moderate food insecurity through food and non-food-based coping strategies. Source: Data processed from survey results

Farmer type	Decreasing the probability of moderate food insecurity			Increasing the probability of moderate food insecurity			
	SideJob = 0	Advantage of Yard = 1	AgricIncome > 1000	AgricIncome (< IDR 500 Thousand)	AgricIncome (IDR 500- 1000 Thousand)	SideJob = 1	Advantage of Yard = 0
Laborers	79.2	22.7	4.5	72.7	22.7	12.5	86.4
Land tenant	11.1	44.4	33.3	22.2	44.4	88.9	55.6
Landowners	52.4	33.3	23.8	23.8	52.4	47.6	57.1

such as trading, buying grain, and selling salt, which raises the possibility that they would face severe food insecurity. On the other hand, 47.6% of farmers who own land report having moderate food insecurity. Their findings suggest that farmers who focus on anything other than agriculture have the potential to confront moderate food insecurity despite their smaller size than land tenants. Ceteris paribus (assuming other circumstances are unchanged) is this conclusion. Additionally, labor farmers need to understand that just 4.5% make more than IDR 1 million, although most focus on working in agriculture. Only 22.7% make between IDR 500 thousand and IDR 1 million monthly, with the vast majority (72.7%) making less than IDR 500 thousand. As a result, labor farmers are likely to encounter moderate food insecurity. To solve this issue and increase income, labor farmers must improve their agricultural abilities. Additionally, labor farmers might plant food crops in their yards as an additional source of nourishment, given that farmers only use their yards for 22.7% of their labor. The results of this study deviate from those of [2], which indicated that non-agricultural occupations are engaged in by Ethiopian female households. This discrepancy is because, in Ethiopia, female households tend to be younger than the cases discussed in this study; specifically, most female farmers in Ethiopia are older (over 50). Younger people are physically more capable of handling a more comprehensive range of tasks or labor. Nonetheless, several research findings support the recommendations made in this study, particularly about raising agricultural output productivity. [20] states that the strategy can supply loan capital enhanced by agricultural technology [5] and financial literacy [20].

An essential point for land tenant farmers is maximizing high-quality agricultural production to raise income. Although most tenant farmers work multiple (side) jobs, 33.3% of tenant farmers currently make more than IDR 1 million from farming. The second coping strategy is to expand the garden to grow food crops there. Since just 44.4% of people are already using their yards, another 55.6% need to persuade them to be interested in growing food crops there. Finally, the data in Table 9 show that

land-owning farmers need to be encouraged to increase their yards for growing food crops because currently, only 33.1% use them. Another coping strategy for land-owning farmers is optimizing their income from farming. Because currently, the income of most land-owning farmers (52.4%) from agriculture ranges from IDR.500 thousand to IDR. 1 million. It could be by focusing more on cultivating agricultural land or cooperating with land tenants with a mutually beneficial profit-sharing system.

Government contribution and social capital in addressing food insecurity of female farmers

The government offers a variety of aid programs to female farmers in addition to its initiatives to combat food insecurity. 79% of social aid goes to female farm laborers through the PKH ("Family Hope Programme"). Only 22.22 percent of labor farmers receive social support from the government infrequently (one to three times a year), compared to labor farmers, who receive assistance on average every three months. Furthermore, land owners and tenant farmers also receive social assistance, although less than farm laborers, 53% for land owner farmers and 67% for tenant farmers. Most land-owning farmers receive cash social assistance, while the sharecroppers primarily receive PKH assistance ("Family Hope Program"). However, some land-owning farmers need social assistance from the government as labor farmers and land cultivators. In interviews with farmers who did not receive social assistance, they said they hoped to receive assistance from the government. They further explained that they did not receive assistance because "…were considered to be in a good position because my husband is a retired civil servant (PNS)…" Some women farmers hoped that government assistance would be focused on elderly farmers because they did not have steady jobs. In addition, the amount of assistance provided must increase, and there is a certainty when assistance will provide. The authorities should be aware that social assistance is merely temporary because if it persists for an extended period, female farmers will grow more dependent on it, increasing the probability of them will experience food insecurity as a result of

their experiences of insecurity when they are no longer eligible for social assistance. The study's results (Table 7) show that female farmers who do not receive government assistance are less likely to experience food insecurity than female farmers who receive government assistance, supporting this conclusion.

The following external factor that characterizes rural communities in Indonesia, especially in West Sleman, is the power of social capital. In the local language, it is called gotong-royong [49]; for example, female farm laborers often receive assistance in the form of rice from their neighbors. Some received financial assistance and crops from neighbors and the local community. Farmers in the Sidama region, Southern Ethiopia, also value the importance of social strategies through community strengthening among female farmers to overcome food insecurity [50]. The values of indigenous knowledge passed down from earlier ancestors, which crystallized into the local culture before being adopted at the national level, are the source of the voluntary mutual help behavior among inhabitants. Consequently, it is not unforeseen that Indonesia, a multiethnic country, holds the highest rank for being the world's most giving nation (as per data from the CAF's World Giving Index) [51]. One of them, the Female Farmers Group (KWT), is a group of female farmers in the form of a formal organization in the villages of Godean and Gamping. According to the explanation in the previous paragraph, KWT benefits female farmers, including members who can borrow money when needed. In addition, members can also share information and strengthen kinship. However, although almost none of the women farmers know about KWT, many still need to register. Moreover, climate change also needs to be anticipated because it can lead to food insecurity. High rainfall and drought are problems for female farmers to deal with. During high rainfall, some plants are submerged in water, especially the small ones, which often die, then drought (no rain) can still be overcome by using a water pump. This climate change occurs erratically and can trigger pest and disease attacks. There are still many female farmers who are overwhelmed in dealing with pests. Thus, the role of the female farmer group is very important in sharing information and helping each other when pest attacks occur. These results are in accordance with [52]. When the harvest fails, sometimes there is no harvest at all, so farmers have to buy their own rice and there is no assistance from the government regarding crop failure, meetings with extension agents are also very rarely held, sometimes if there is counseling new farmers ask regarding the management of the failed harvest to extension agents so can reduce the risk for the next growing season.

The present study offers three recommendations to female farmers facing food insecurity: strengthening coping strategies, availing government assistance, and being involved in farmer associations. The outcomes of Abebe's research [50] confirm that to assist female farmers in reducing food insecurity, the government must play a more prominent role in enhancing their capacity to know how to farm appropriately for the local environmental conditions. The idea is that families can rely on something other than the market to meet their food needs. Furthermore, the government's function is to enhance social capital via initiatives that promote neighborhood harmony.

Conclusions

Based on these findings, more than 50% of farm workers, land owners, and land tenants do not face food insecurity and are in a state of food security. However, compared to owners and tenants, the percentage of agricultural workers who experience mild, moderate, and severe food insecurity is more significant. Based on these findings, those in the studied area are between 60 and 70 years old, and up to 50% work as farmers to ensure food security for their households. 68% of female farmers generally earn less than IDR 500 thousand monthly. The primary cause is the restricted expenditure, which amounts to less than IDR 500 thousand and is barely sufficient to purchase essentials like rice. Compared to landowners (14%) and the fewest land cultivators (11%), laborers experience a higher proportion of moderate-to-severe food insecurity (23%). Efforts to alter behavior are required to decrease the likelihood of moderate and severe food insecurity. These include managing spending on food priority over non-food things, using the yard to grow food crops (physical access), and not depending on government social aid. However, mitigation measures such as saving money and leading a basic or thrifty lifestyle are required. Additionally, keeping positive relationships with neighbors and the community is crucial to providing financial support when food insecurity arises. Lastly, female farmers need to devote the best amount of time to the agricultural sector to boost their income. In order to support farmers' attempts to overcome food shortages by utilizing their surroundings, the government must play a role in strengthening social capital in the farmer's environment. The respondents for this research were limited to farmers in West Sleman, one of the districts in Yogyakarta, Indonesia. Further research can expand the reach of respondents to the national level.

Availability of data and materials

Not applicable.

Declarations

Ethics approval and consent to participate

We approve and consent.

Consent for publication

We consent.

Competing interests

Authors declare no competing interests.

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