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DO LIVELIHOOD CAPITALS IMPROVE FOOD SECURITY AMONG SMALLHOLDER FARMERS? EVIDENCE FROM HORTICULTURE FARMERS IN EAST JAVA, INDONESIA

Syafrial Syafrial[a] †
Hery Toiba[a]
Dwi Retnoningsih[a,b]
Tina Sri Purwanti[b]
Moh. Shadiqur Rahman[a]

[a]*Agriculture Socio-economic Department, Faculty of Agriculture, Brawijaya University, Malang 65145, Indonesia.*
[b]*Department of Tropical Agriculture and International Cooperation, National Pingtung University of Science and Technology, Pingtung 912, Taiwan.*

† ✉ *syafrial.fp@ub.ac.id (Corresponding author)*

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ABSTRACT
The purpose of this study is to assess the impact of livelihood capitals on smallholder farmers' food security. This study employed cross-sectional data from 300 smallholder farmers in the Malang Regency of East Java, Indonesia. The household food expenditure and food consumption score (FCS) were applied to assess farmers' household food security status. Furthermore, the data were analyzed using multiple linear regression to estimate the effect of livelihood capitals on food expenditure, and an ordered probit regression model was used to assess the effect of farmers' livelihood capitals on FCS. The average farmers' food expenditure was about 68.124 USD per month; using FCS status, 12.33% of respondents were categorized as poor with an FCS of less than 21.5, 67.00% were categorized as borderline with an FCS score of 21.5 to 35, and 20.67% were categorized as acceptable with an FCS of more than 35. The result indicated that social capital (farming group, relations, social activity, and market information) was the most essential variable affecting household food as measured by expenditure as well as FCS, followed by human capital (education, experience, and family labor), financial capital (access to credit), and physical capital (agricultural storage and market distance). These findings suggest that there is a need to improve social access, farmers' abilities, and the agricultural infrastructure of smallholder farmers to enhance their food security.

Contribution/Originality: This study makes an essential contribution to the literature and agricultural policy by providing empirical evidence regarding the influence of horticulture farmers' livelihood capitals on household food security status in a developing country, namely Indonesia.

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1. INTRODUCTION

Food security and diet are crucial challenges in global development (Szabo et al., 2018). The FAO (2018) claimed that two billion people were suffering from malnutrition; 155 million children under 5 were starving, and 41 million were overweight. Reducing food insecurity is a global concern for the sustainable development goals (SDGs), which require a pledge to zero hunger, reduced food inequality, and increased nutrition by 2030 (Nkomoki, Bavorová, & Banout, 2018). According to the United Nations (2015), the second SDG is to "*achieve global food security, increase people's nutrition and encourage sustainable agriculture.*" To achieve this SDG, the agriculture sector is specifically required to contribute to reaching this goal. Agriculture can improve global food security and nutrition through two channels: first, by increasing the quantity and diversity of the food supply, and second, by providing an income to the people who engage in this sector (HLPE, 2020). Ahmed, Ying, Bashir, Abid, and Zulfiqar (2017) suggested that increasing agricultural product prices could be a factor in reduced food access and availability. A study conducted by Abdelhedi and Zouari (2020) reported that increasing agricultural production is essential to support the food demand. As a result, agriculture may improve food and nutrition security by giving households direct access to staples and additional food. Although the agricultural sector plays an important role in global food security, farmers' households, as the agricultural actor, may face several barriers to achieving food security, particularly because they have limited resources to obtain the food they need. At the household level, food security is not only determined by the adequacy of the food supply, but also by household purchase power, which impacts household food expenditure (Agidew & Singh, 2018; Guellil & Benhabib, 2022). A study conducted by Ahmed et al. (2017) found that smallholder farmers were forced to spend 70% of their income to purchase food. However, they need to reduce their food expenditure due to other expenses, such as health, education, and transportation. On the other hand, Scoones (1998) suggested that livelihood capitals – human capital, physical capital, natural capital, social capital, and financial capital – are the essential factor in household outcomes such as food security. For instance, farmers with higher financial capital tend to have higher purchasing power, thereby improving their food supply (Shobe, Narcisse, & Christy, 2018). Moreover, Manlosa, Hanspach, Schultner, Dorresteijn, and Fischer (2019) claimed that households can generate food security by combining their livelihood capital to construct livelihood strategies. The combination of livelihood capitals in a process requiring human agency and resourcefulness to build livelihood strategies and produce livelihood outcomes (i.e., food security) However, smallholder farmers have lacked access to livelihood capitals due to multiple threats, such as social change, environmental issues, limited financial resources, and low literacy levels (Kuang, Jin, He, Ning, & Wan, 2020; Nwofoke & Odoh, 2021). Similarly, Qi and Dang (2018) also found that smallholder farmers in developing countries were essentially vulnerable to livelihood risks that affected their food security.

To enhance smallholder farmers' food security, international studies have investigated factors associated with household food security. For instance, Mango, Zamasiya, Makate, Nyikahadzoi, and Siziba (2014) assessed the impact of the socioeconomic factor on farmers' household food security; their results indicated that education level, age, family labor, household size, livestock ownership, household remittance, and market information significantly affected farmers' household food security. Reincke et al. (2018) estimated the influence of agriculture-related factors on food security, finding that farmers' food security was affected by pesticide usage, market availability, processing quality, farmers' knowledge, and social participation. Furthermore, a study conducted by Neelakantan, DeFries, Sterling, and Naeem (2020) revealed that financial capital was the most essential factor associated with increased household food consumption. Ali and Erenstein (2017) investigated the impact of farmers' adaptation practices in response to climate change. Their findings revealed that adaptation practices were able to improve farmers' food security. Toiba, Nugroho, Retnoningsih, and Rahman (2020) evaluated the impact of modern market participation on smallholder farmers' food security by controlling the selection bias between observable and unobservable variables. They claimed that farmers who participated in modern markets had higher food security status. On the other hand, Magrini and Vigani (2016) investigated the link between physical capital, such as technology adoption, and food security. They found a link between technology adoption and food availability, access, utilization, and stability. Although the previous literature has investigated factors associated with farmers' food security, there is a lack of studies that explore the effects of livelihood capitals (human capital, physical capital, natural capital, social capital, and financial capital) on farmers' food security status. Hence, to fill this gap, the current study assessed the effect of livelihood capitals on farmer's food security status. To assess the effects of livelihood capitals on food security, this study employed cross-sectional data from smallholder farmers and adopted a sustainable livelihood approach that was introduced by the Department for International Development (DFID) (Scoones, 1998).

2. RESEARCH METHOD

2.1. Data Collection

Research data was obtained from smallholder horticulture farmers in East Java, Indonesia. The horticulture farmers were selected as our respondents for two reasons: first, horticulture is more vulnerable to environmental change, such as pests and plant diseases, climate change, and natural disasters, than other crops such as staple food commodities. Second, the price of horticulture products in Indonesia is subject to high fluctuation. The research was conducted in Malang and Kediri Regencies, East Java Province, Indonesia. The location was chosen purposively because horticulture production in Malang and Kediri Regencies is more advanced than in other regions of East Java (Wandschneider, Gniffke, Kristedi, Boga, & Adiyoga, 2019). Two sub-districts were chosen in each regency, namely Ngantang and Pujon in Malang, and Banyakan and Kepung in Kediri. These districts are the production centers of horticulture farms in each regency. 75 smallholder horticulture farmers per district were considered as research respondents. As a result, 300 horticulture farmers were randomly selected. Furthermore, research interviews were employed for the data collection, using a structured questionnaire. The head of household for each horticulture

farmer was selected for the interview. The research questionnaire covered household characteristics, farmers' livelihood capitals, and household food consumption over the last seven days. Additional secondary information was gathered from journals, review papers, books, annual accounts, and other related resources.

2.2. Research Variables

2.2.1. Food Security Measurement

To estimate household food security, this study used two indicators: household food expenditure and food consumption score (FCS). Household food expenditure was measured as the total household expenditure on food (USD per month). The second food security indicator, FCS, was introduced by the World Food Program as a measure of household food security status by looking at the weighted frequency of the dietary diversity score (Leroy, Ruel, Frongillo, Harris, & Ballard, 2015). The FCS provides a composite score that contains data on dietary diversity, the frequency of group food consumption, and each food group's nutritional value by giving different food groups different weights. There are eight food groups, and each group has its own score: main staple (2 points), pulses (3 points), vegetables (1 point), fruit (1 point), meat and fish (4 points), milk (4 points), sugar (0.5 points), and oil (0.5 points). After the household's total food points are calculated, the FCS is determined. The FCS categorizes households' food security status into the three following categories: poor, with an FCS of less than 21.5; borderline, with an FSC of 21.5 to 35; and acceptable, with an FCS of more than 35 (Wfp, 2008).

2.2.2. Livelihood Capital

The selection of the livelihood capital variables was based on the sustainable livelihood approach (SLA) developed by the DFID (Scoones, 1998). There are five types of livelihood capital; these are human capital, physical capital, natural capital, social capital, and financial capital.

a. Human Capital

Human capital represents both quantity (human resources) and quality (skills, knowledge, and ability). At the household level, human capital plays an essential role in achieving household outcomes such as food security. In this study, human capital was divided into five variables: age, education, experience, household size, and family labor.

b. Physical Capital

Physical capital comprises the basic and productive infrastructures that are needed to produce livelihood outcomes. This capital can help people to maintain their livelihood and make them more productive. The physical capital variables used in this research included agricultural storage, electricity, and market distance.

c. Financial Capital

Financial capital consists of the financial resources that can be used to achieve livelihood outcomes. These financial resources can include financial stock, such as savings, or capital, such as livestock, that can support human financial needs. Financial capital variables used in this study included access to credit, savings, and off-farm jobs.

d. Social Capital

In terms of sustainable livelihood, social capital is defined as a social resource that can enhance household livelihood outcomes. Social capital consists of networks and relations between individuals (horizontal), and between individuals and communities or institutions (vertical) that increase farmers' access to and information about the things they need to maintain their livelihood. The social capital variables used in this study included farmers' groups, cooperative membership, relations, social activity, and market information.

e. Natural Capital

Natural capital is a term that is used to represent the availability of natural resources that contribute to livelihood outcomes. Natural resources can be divided into common property, such as the atmosphere, water supply, and biodiversity, and private property, such as land. Natural capital variables used in this study included the natural resources that can be controlled by the farmers, such as total land area and water supply.

2.3. Data Analysis

2.3.1. Multiple Linear Regression

To investigate the possible effects of livelihood capitals on household food security in East Java, Indonesia, we employed variables for each of the five livelihood capitals as a function of the household food security status, which was measured by food expenditure in this model. First, we analyzed the effect of the livelihood capitals on food expenditure using multiple linear regression. The model included food expenditure *(food EXP)* as the dependent variable, and the explanatory variables were age (*age*), education *(educ)*, experience (*experience*), household size *(hhz)*, family labor *(flabor)*, agricultural storage *(storage)*, agricultural electricity *(elect)*, market distance *(dmarket)*, access to credit (*credit*), savings *(saving)*, livestock ownership *(capital)*, off-farm jobs *(off_farm)*, farmer group *(f_group)*, cooperative membership *(cooperative)*, relations (*relation*), social activity *(s_activity)*, market information *(minfo)*, total agricultural land *(tarea)*, and water supply *(water_s)*. The study's multiple linear regression model can be written as follows:

$$FoodEXP = \alpha + \beta 1Age + \beta 2educ + \beta 3expericence + \beta 4hhz + \beta 5flabor + \beta 6storadge + \beta 7elect + \beta 8dmarket + + \beta 9credit + \beta 10saving + \beta 11off\_farm + \beta 12Fgroup + \beta 13cooperative + \beta 14relation + \beta 15sactivity + \beta 16minfo + \beta 17tarea + \beta 18waters + e$$

where α is a constant that represents the value of FCS if the independent variables are unavailable. Furthermore, βi is the coefficient of regression, and e is the error term.

2.3.2. Ordered Probit Regression

The multilinear regression model was limited to estimating the impact of livelihood capitals on farmers' food security, measured by the food consumption score. To more closely analyze the effect of livelihood capital on the farmers' food security category, we employed the ordered probit model. In this study, the dependent variable could take values 1, 2, or 3, depending on the categorized food consumption score. Value 1 if the farmers' food security was categorized as poor, value 2 if the food security was categorized as borderline, and value 3 if the food security was categorized as acceptable. The ordered probit model was more suitable in this research than the multinomial model because the category of the dependent variable was ordinal Wfp (2008). The ordered probit model is assessed using the following equation

$$Y\_cfcs = x\beta + e\_i$$

where *y_cfcs* is the observable variable (categorized food consumption score) x is the explanatory variables (farmers' livelihood capitals), e is N (0,1), and i = 1, 2, 3….N. Furthermore, the probability of the ordered probit model can be written as follows:

$$Prob\,[y_i = j] = \varphi\,(\mu_j - x_i\beta) - \varphi\,(\mu_j - 1 - x_i\beta)$$

where the cumulative distribution fiction is given by φ, and j is the categorized food consumption score.

Table 1. Descriptive statistics of variables used in the research.

Variables	Definition	Mean	Std. Dev
Food Expenditure	Total household expenditure on food (USD/month)	68.124	37.915
FCS	1. if Poor 2. if Borderline 3. if Acceptable	2.083	0.569
Human Capital			
age	Farmer age in years	47.537	11.398
educ	Highest education level in family (years)	7.997	2.628
experience	Farmer experience in farming activity (year)	21.690	12.181
hhz	Total number of family members	2.593	1.019
flabor	Dummy 1 if household has labor in family; 0 for others	0.557	0.498
Physical Capital			
storage	Dummy 1 if farmers have agricultural storage; 0 for others	0.330	0.478
elect	Dummy 1 if farmers have agricultural electricity; 0 for others	0.287	0.528
dmarket	Distance from agricultural land to agricultural market (Km)	5.096	2.873
Financial Capital			
credit	Dummy 1 if farmers have access to credit; 0 for others	0.653	0.477
saving	Dummy 1 if farmers have savings; 0 for others	0.863	0.664
off_farm	Dummy 1 if farmers have off-farm job; 0 for others	0.447	0.498
Social Capital			
f_group	Dummy 1 if farmers participate in a farmers' group; 0 for others	0.630	0.484
cooperative	Dummy 1 if farmers participate in an agricultural cooperative; 0 for others	0.240	0.428
relation	Dummy 1 if farmers have relations who are farmers in other villages; 0 for others	0.250	0.434
s_activity	Dummy 1 if farmers participated in social activity; 0 for others	0.657	0.476
minfo	Dummy 1 if farmers have market information; 0 for others	0.500	0.501
Natural Capital			
t_area	Total area of land cultivated (Ha)	0.323	0.601
warter_s	Dummy 1 if farmers have improved water supply; 0 for others	0.170	0.418

3. RESULTS

3.1. Descriptive Statistics

The respondents of this research were 300 horticulture farmers. Table 1 shows the descriptive statistics of variables used in this research. The average age of farmers in this study was 47.53 years; the average highest education level in the family was 8 years (or senior high school), and the average experience in farming activity was

21.69 years. The average household size was between 2 and 3 people per household, and 55.7% of respondents had workers among their family members. Furthermore, the physical capital variables indicated that 33% of our respondents had agricultural storage to store their yield. 28.7% of our sample had additional agricultural electricity, i.e., electricity used by farmers to support agricultural activities, such as lamps. The average agricultural market distance from farmers' cultivated land was about 5.096 kilometers. The market distance used in this study was the distance from the farmer's house to a traditional market. The financial capital variables showed that 65.3% of our respondents had access to credit. Credit was accessed by the farmers from formal financial institutions, microfinance institutions, and the government. The savings variable showed that 86.3% of the respondents had financial savings. Moreover, farmers not only had an income from their farming activity, but also from off-farm activities such as private employment, aquaculture, trade, and entrepreneurship. The data indicated that 54.7% of farmers in this study participated in off-farm jobs. Also, the social capital variables used in this study showed that 63.0% of farmers participated in farmers' groups, 24% participated in agricultural cooperatives, and 25.7% had access to relations. The relation variable represented the farmers' relationships with farmers in other villages. Social activities, such as community service and cultural and religious activities were participated in by 65.7%. Lastly, 50.0% of farmers had access to agricultural market information; the market information was accessed via extension agents and farmers' communities. The natural capital distribution of this study indicated that the average cultivated land area was about 0.323, with 17.0% of farmers having irrigation improvements to supply agricultural water.

The dependent variables used in this study were food expenditure and food consumption. The average household food expenditure in this study was 68.124 USD per month. The second dependent variable was FCS. We categorized the score based on Wfp (2008) as 1 if in the poor category, 2 if borderline, and 3 if acceptable. The mean value of the FCS variable was about 2.083, showing that the average farmer in this study was in the borderline category.

3.2. Multiple Linear Regression

This section presents the result of a multiple linear regression model to assess the effect of livelihood capital on households' food expenditure. The result of the multiple linear regression models is shown in Table 2. We found that social capital, such as farmer groups, relations, social activities, and market information, were essential to households' food expenditure, followed by access to credit (financial capital), agricultural storage, and market distance (physical capital), and education, farmer experience, and family labor (human capital). To start with human capital, this study found that education had a positive and significant impact on food security with a regression coefficient of 1.710. This finding implies that increasing farmers' education level by one year will improve farmers' food expenditure by about 1.710 USD. Experience had a positive and significant impact on food expenditure, with a regression coefficient of 0.296. This indicates that an increase in the farmer's experience by one year leads to an increase in the farmer's food expenditure by 0.296 USD. Furthermore, family labor positively affected household expenditure. This means that farmers who have family labor are more likely to have higher food expenditure levels than those who do not.

Table 2. The impact of livelihood capitals on food expenditure.

Variables	Coefficient	Std. Error	t-value	P>|t|
Human Capital				
age	-0.179	0.190	-0.940	0.347
educ	1.710	0.729	2.350	0.020**
experience	0.296	0.169	1.750	0.081*
hhz	-2.997	1.835	-1.630	0.104
flabor	10.021	3.975	2.520	0.012**
Physical Capital				
storage	8.981	4.155	2.160	0.032**
elect	2.890	3.575	0.810	0.420
dmarket	-2.620	0.670	-3.910	0.000***
Financial Capital				
credit	8.851	4.058	2.180	0.030**
saving	-0.369	2.922	-0.130	0.900
off_farm	-2.625	3.988	-0.660	0.511
Social Capital				
f_group	7.355	3.947	1.860	0.063*
cooperative	3.782	4.749	0.800	0.427
relation	22.147	4.815	4.600	0.000***
s_activity	10.422	4.367	2.390	0.018**
minfo	8.081	3.984	2.030	0.043**
Natural Capital				
t_area	2.438	3.096	0.790	0.432
warter_s	0.095	4.607	0.020	0.984
Cons	41.341	12.574	3.290	0.001
Adj. R-Squared	0.347			
Prob > F	0.000			

Note: *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

The significant effect of physical capital on households' food expenditure was indicated by the agricultural storage and market distance variables. The results show that farmers with agricultural storage tended to have higher food expenditure levels than farmers without. The market distance variable showed a negative and significant impact on farmers' food expenditure. The value of the regression coefficient was -0.620, with a 1% significant level. The value indicates that increasing the market distance by 1 kilometer leads to a reduction in household food expenditure of -0.282. This finding suggests that the agricultural market plays an important role in household access to food. Market access also makes it easier for the farmer's household to buy food, so it is part of the household food availability scheme. The impact of financial capital on households' food expenditure was represented by access to credit, which had a positive and significant impact on household food expenditure. Farmers with access to credit had a higher level of food expenditure by about 8.981 USD.

Four social capital variables had a significant effect on food consumption scores. First, membership in a farmers' group had a positive effect, which was significant at 10%, and the value of the coefficient was 7.355. This indicates that farmers who participate in farmers' groups have higher food expenditure (by about 7.355 USD) than farmers who do not participate. Second, relations with other farmers had a positive impact on food expenditure, with a coefficient value of 22.147. The value indicates that farmers with relations who are farmers in other villages are likely to have a higher food expenditure by about 1.343. Third, the social activity variable had a positive and significant effect on food expenditure. The value of the coefficient implies that farmers who participate in social activities have higher food expenditure levels than farmers who do not. Lastly, market information also had a positive impact with a 5% significance level. The finding indicates that farmers with access to market information have a higher food expenditure of about 8.081. The finding shows that market information plays a role in farmers' food security because market information provides the potential to earn a higher income, and thus increase farmers' purchasing power.

Table 3. The impact of livelihood capital on farmers' FCS.

Variables	Coefficients	z-value	Marginal effects					
			Poor		Borderline		Acceptable	
			dy/dx	z-value	dy/dx	z-value	dy/dx	z-value
Human Capital								
age	-0.015	-1.710*	0.001	1.610	0.001	1.570	-0.002	-1.710*
educ	0.074	2.200**	-0.005	-1.940*	-0.007	-1.860*	0.012	2.110*
experience	0.029	3.740***	-0.002	-2.830***	-0.003	-2.600***	0.005	3.490***
hhz	0.032	0.390	-0.002	-0.390	-0.003	-0.380	0.005	0.390
flabor	0.032	0.180	-0.002	-0.180	-0.003	-0.180	0.005	0.180
Physical Capital								
storage	0.153	0.810	-0.010	-0.790	-0.015	-0.790	0.025	0.800
elect	0.127	0.760	-0.008	-0.760	-0.012	-0.740	0.021	0.760
dmarket	-0.134	-4.310***	0.009	3.110***	0.013	2.760***	-0.022	-3.960***
Financial Capital								
credit	0.719	3.900***	-0.047	-2.870***	-0.070	-2.580***	0.117	3.480***
saving	0.030	0.230	-0.002	-0.230	-0.003	-0.230	0.005	0.230
off_farm	-0.147	-0.810	0.010	0.810	0.014	0.790	-0.024	-0.810
Social Capital								
f_group	0.620	3.450***	-0.040	-2.600***	-0.060	-2.490**	0.101	3.160***
cooperative	0.718	3.290***	-0.047	-2.560**	-0.070	-2.400**	0.116	3.030***
relation	0.923	4.120***	-0.060	-2.890***	-0.090	-2.670***	0.150	3.640***
s_activity	0.905	4.310***	-0.059	-3.200***	-0.088	-2.780***	0.147	4.060***
minfo	0.484	2.590***	-0.031	-2.320**	-0.047	-2.140**	0.079	2.590**
Natural Capital								
t_area	0.191	1.380	-0.012	-1.300	-0.019	-1.290	0.031	1.360
warter_s	0.072	0.360	-0.005	-0.360	-0.007	-0.360	0.012	0.360
Log-likelihood	-156.803							
LR chi2(17)	196.960							
Prob > chi2	0.000							
Pseudo R2	0.386							

Note: *, **, *** denote significance on 10%, 5%, and 1% respectively.

3.3. Ordered Probit Model

The results of the ordered probit model are presented in Table 3. The results for human capital indicated that older farmers were associated with a 0.20% lower probability of being in the acceptable category. The farmers' education had a positive and significant effect on FCS; the marginal effect model showed that increasing the education level improved farmers' probability of being in the acceptable category by about 1.20%, and decreased farmers' probability of being in the borderline and poor categories by 0.30% and 0.020%, respectively. Furthermore, the experience variable had a positive and significant effect on household FCS. Farmers with more experience in agricultural activity were more likely to be in the acceptable category (0.50%). In contrast, they were less likely to be in the poor and borderline categories (0.30% and 0.20%, respectively). The influence of physical capital on FCS

demonstrated that market distance had a negative relationship with FCS. The farmers furthest from the market were 2.00% less likely to be in the acceptable category, but 1.30% more likely in the borderline category, and 0.90% more likely to be in the poor category.

The significant effect of financial capital on FCS was indicated by access to credit; farmers who had access to credit were 11.70% more likely to be in the acceptable category, 7.00% less likely to be in the borderline category, and 4.70% less likely to be in the poor category. On the other hand, social capital's effect on food consumption indicated that farmers who participated in farmers' groups were 4.00% less likely to be in the poor category, 6.00% less likely to be in the borderline category, and 10.10% more likely to be the acceptable category. Furthermore, farmers who participated in cooperatives were 4.70% less likely to be in the poor category, 7.00% less likely to be in the borderline category, and 11.60% more likely to be in the acceptable category. Relations had a positive and significant effect on farmers' FCS. Farmers who had a relation who was a farmer in another village were about 15.0% more likely to be in the acceptable category and about 9.00% and 6.00% less likely to be in the borderline and poor categories, respectively. Participation in social activities also had a positive relationship with farmers' FCS. Participation in social activity decreased farmers' likelihood of being in the poor category by about 5.90%, and of being in the borderline category by 8.80%. However, it improved farmers' likelihood of being in the acceptable category by about 14.00%. The last social capital variable in this study was access to market information, which had a positive and significant impact on farmers' FCS. Farmers who had access to market information were 3.10% less likely to be in the poor category and 4.70% less likely to be in the borderline category, but 7.9% more likely to be in the acceptable category.

4. DISCUSSION

This section discusses the impact of livelihood capitals on farmers' food security in East Java, Indonesia, using the measures of food expenditure and FCS. Five types of livelihood capital were employed in this study, based on the sustainable livelihood framework developed by DFID: human capital, physical capital, financial capital, social capital, and natural capital. Based on this study's findings, four of these capitals play an essential role in farmers' food security: human capital (age, education, experience, family labor), physical capital (agricultural storage and market distance), financial capital (access to credit), and social capital (farmers' group membership, cooperative membership, relations, social activity, and market information).

a. Human Capital

The impact of human capital on farmers' food security is apparent in the effects of farmers' age, education, and experience in agricultural activity, as well as family labor. The older farmers were more exposed to food insecurity than the younger farmers. In the 21st century, the increase in technology development is bringing about important changes in agricultural activity; with technology adoption, farmers are more productive and find it easier to obtain an adequate amount of food. Younger farmers are more likely to accept new technologies than older farmers; older farmers tend to use traditional methods or practices to meet their livelihood needs. In contrast, younger farmers are more likely to accept and apply technological developments (Rahman, Huang, Toiba, & Efani, 2022; Syafrial, Rahman, & Retnoningsih, 2021). As a result, younger farmers are more likely to meet their livelihood needs, especially in terms of food. This finding is in line with research conducted by Mustapha, Kamaruddin, and Dewi (2018), who used data from 4,288 households in northern Ghana to estimate the impact of household characteristics on household food insecurity. Their findings indicated that the age of the household head had a positive and significant effect on household food insecurity. The second type of human capital that played an essential role in farmers' food security was farmers' education level. In agricultural activity, education affects food security through access to knowledge on the best practices in farming, nutrition, and sanitation; improved efficiency, hence higher production levels and better decision-making; and pride in education. On the other hand, education may improve household food security by providing employment, better income, and better decision-making. This result supports the studies conducted by Mutisya, Ngware, Kabiru, and Kandala (2016) and Rahman, Andriatmoko, et al. (2022), who investigated the effect of education on household food security status in Kenya. Using the ordered probit model, they found a significant effect of education on household food security. The likelihood of being food insecure was reduced by 0.019 for each unit increase in the average number of years of schooling for a specific household. Finally, the last human capital variable that improved farmers' food security was farmers' experience in agriculture activity. Farmers' experience improves food security by increasing efficient farming practices that provide higher yields, as well as income that can improve food and purchasing power. Nkomoki et al. (2018) assumed that more experienced farmers would be better able to comprehend and recognize changes in farming techniques. On the other hand, family labor was found to support farmers' food security as well, as indicated by the higher food purchasing power for household food consumption.

b. Physical Capital

The important role of physical capital in farmers' food security was apparent in the agricultural storage and market distance variables. In this research, agricultural storage was essential for farmers. This physical capital enables farmers to keep their produce longer. For instance, when farmers have no deal with a buyer at the desired price for the agricultural produce, they can save it and look for another buyer who is willing to pay a higher price. As a result, they can earn a higher income and improve their purchasing power for food needs. Furthermore, the market distance variable represents the distance between farmers' houses and the traditional market. In rural areas, the traditional market can improve household food security by providing various food supplies, such as the main staple, fruit, meat, and fish, at cheaper food prices. The distance to a traditional market is related to farmers' access to this

market, whereas a greater distance to a traditional market makes farmers less likely to visit this market. In contrast, a short distance to a market tends to improve farmers' propensity to visit and buy the food they need at the market. This finding supports the study of Mohammed, Wassie, and Teferi (2021), who investigated the determinants of smallholders' food security status in Northern Ethiopia. Using the binary logit model, they found that market distance had a significant negative effect on smallholders' food security status. Furthermore, a study conducted by Ahmed et al. (2017) provided the same finding. Using household data in Pakistan, they suggested that factors of market accessibility (road distance and travel costs) greatly impacted food security in small-scale agricultural households. More specifically in Indonesia, Rahman, Toiba, and Huang (2021) found a positive association between marketing choice and food security.

c. Financial Capital

Access to credit is a type of financial capital that plays an important role in improving farmers' food security. Financial capital has an essential role in farming activity, especially for smallholder farmers. They often fail to achieve maximum productivity in their farming activities because they are unable to buy the inputs they need, such as fertilizer, seeds, and pesticides. Consequently, they are more likely to suffer from low incomes and reduced purchasing power for food. Access to credit is one type of financial capital that can solve this problem by providing financial support for smallholder farmers. This finding is in line with a previous study conducted by Bidisha, Khan, Imran, Khondker, and Suhrawardy (2017), who investigated the impact of access to credit on food security. Using propensity score matching analysis, they suggested that access to credit improves food security and helps households attain more dietary diversification. Diagne (1998) argued that access to credit improves farmers' incomes and food security by enabling households to reduce their borrowing from informal sources.

d. Social Capital

The impact of social capital on farmers' food security status was observed in five variables: participation in farmers' groups, cooperative membership, relations, social activity, and market information. First, participation in farmers' groups improved farmers' food security status. Farmers' groups are associated with social connections, which provide a lot of information that can increase farming productivity, such as on irrigation, input, and climate. On the other hand, farmers' groups are also associations where farmers can share their experiences and where problems can be solved together with the other members. Hence, they can help improve farming activities, which in turn affect food security. Moreover, farmers' groups are also vital institutions for farmers to expand their livelihood strategies. For instance, membership can provide networks and links that can empower people or groups with different businesses to improve revenue generation, as well as nutrition programs to deal with food insecurity concerns. Next, agricultural cooperatives play an essential role in increasing farmers' food security by improving the farmers' efficiency, as well as their income and food safety. A study conducted by Abate, Francesconi, and Getnet (2014) estimated the effect of cooperative membership on technical efficiency. The study found that farmers who participated in cooperatives tended to have higher technical efficiency than those who did not. Ma and Abdulai (2016) investigated the well-being impact of cooperative membership on smallholder farmers in China. Their findings revealed that cooperative membership improved farmers' well-being by increasing yields, farm net returns, and incomes. As a result, farmers found it easier to fulfill their food needs.

Third, relationships or networks with other farmers, especially outside the village, was a type of social capital that could improve farmers' food security by providing agriculture-related information that did not exist in their village. For instance, when farmers lack agricultural inputs such as fertilizer and seed in their village, they can get these inputs in another village by getting information from their relations. This can mitigate farmers' failures in their farming activity. Fourth, social activity is a vital form of social capital that can improve farmers' livelihood outcomes, including food security. In this study, social activity was defined as cultural or religious activities in the community. Such activities can strengthen the connections between people and increase their sharing with one another. The final form of social capital that can improve food security is market information. Market information can improve farmers' food security by allowing them to obtain better prices for their agricultural products, which can improve their income and their purchasing power for food.

5. CONCLUSION

This study examined the effect of different livelihood capitals on farmers' food security using household survey data. The data were analyzed by multiple linear regression and an ordered probit model. There are four critical findings from the paper. The first is that human capital, including education, experience, and family labor, is essential to improve farmers' food security. Second, physical capital, represented by agricultural storage and market distance, has a positive impact on farmers' food security. Third, access to credit represented the important role of financial capital in farmers' food security status. Fourth, social capital, including membership in farmers' groups, cooperative membership, relations with other farmers, and market information, is an essential factor in farmers' food security. Hence, these findings have important policy implications. The first policy message is to improve the quality of farmers by giving them the training to diversify their skills, which can improve their human capital. Second, provide transportation access to traditional markets so that farmers' households can more easily reach the markets. Third, improve social institutions, such as farmers' support groups, agricultural cooperatives, connections between farmers, cultural and religious activities, and market information, especially for small-scale farmers in rural areas.

One limitation of this research was that we only used two indicators to estimate farmers' household food security: food expenditure and the food consumption score (FCS). To support this study's findings, future research

can be improved by using other food security measures, such as the household dietary diversity score (HDDS), the household food insecurity access scale (HFIAS), or the food insecurity experience scale (FIES).

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