What are Farmer Household Coping Strategies for Facing Crop Loss: Evidence from Indonesia

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Abstract

The climate change that has occurred in the last decade has seriously impacted food availability and price pressures from the macro side, as well as the sustainability of farming activities and the welfare of farmers from the micro side. One form of climate change is crop failure; thus, to anticipate crop failure, farming households implement coping strategies to survive well. This study aimed to analyse the coping strategies used by farm households to deal with crop failures. The data used in this study were sourced from the Indonesian Family Life Survey (IFLS) conducted in 2007 and 2014. There were 3338 samples of farming households in a panel data format that could be used in the analysis. The analytical method used in this study uses a fixed effects approach at the household and rural levels to avoid potential bias from endogeneity and heterogeneity problems. The results showed that the coping strategies adopted by farming households were more likely to sell livestock and household assets and increase the number and frequency of loans. Reducing consumption has not been statistically proven as a coping strategy chosen by farming households facing crop failure.

Introduction

Climate change over the last decade has had a major impact on human life. Climate change has an impact, one of which is on agricultural activities carried out by farmers, in addition to changing planting schedules, so that production is not fulfilled due to crop failure. Crop failure will affect the acceptance and sustainability of farming and, at the macro level, will affect food security and the national economy (Sherony et al., 1991; Berloffa and Modena,

2013; Arora, 2019; Harvey et al., 2014). Crop failure will cause the food supply to decrease, pushing food prices to increase, and causing inflation (Porter, 1962; Samal et al., 2022). On the other hand, crop failure affects the income of farming households (Berloffa and Modena, 2013; Kharisma, 2017; Zhao et al., 2019). In the long run, a decline in farmers' income will impact the sustainability of farming activities and their welfare. The main cause of crop failure experienced by farmers is climate change, which causes floods, other natural disasters, pest and disease disturbances, and droughts.

Climate change has a huge impact and is experienced by all countries in the world, including Indonesia. The country is an agriculture-based country with a large number of farmers. The results of the 2018 Inter-Census Agricultural Survey (*Survey Pertanian Antar Sensus*-SUTAS) - BPS show that the number of Agricultural Business Households (*Rumah Tangga Usaha Pertanian* - RTUP) is 27.6 million HHs, and most of them are poor groups (15.5 million people are in rural areas) and have narrow agricultural land (average, less than 0.5 ha). The climate change that has occurred in recent years has made most farmers vulnerable to shocks, especially crop failures.

Economic or income shocks experienced by farming households due to crop failure affect their welfare. Several studies related to the shock experienced by farming households due to crop failures have encouraged farmers to adopt anticipatory strategies. Coping strategies carried out by farmers include reducing consumption (smoothing consumption) (Morduch, 1995; Dercon, 2002), selling assets (Berloffa and Modena, 2013), including fixed assets and farming/livestock, borrowing funds or applying for credit (Udry, 1994; Liu et al., 2010; Pradhan and Mukherjee, 2018), and adjusting the labour supply (Cameron and Worswick, 2003; Kochar, 1999). The choice of strategy chosen by rural households depends greatly on the type of shock, as well as the characteristics of the agricultural household,

surrounding communities, and economic conditions in the region (Thornton et al., 2007; Chuku and Okoye, 2009; Oyekale and Oladele, 2012). Of course, studies related to welfare and shocks experienced by farmer households are of concern to policymakers, as farmers do not experience greater losses.

In general, empirical studies place more emphasis on the impact of climate change on farmers' production and income, not on the overall strategy adopted by farmers to anticipate the crop failures they experience. Based on the description of the Indonesian agricultural sector, inseparable from various risks, and the results of previous empirical studies, this study aimed to analyse the coping strategies of farming households in Indonesia in experiencing climate change proxied by crop failure. The contribution of this research is the policy implications proposed by the government to help farmers deal with climate change.

Methods

Data

This study used data from The This Indonesian Family Life Survey (IFLS)/ the *Survei Aspek Kehidupan Rumah Tangga Indonesia* (SAKERTI). IFLS is a socioeconomic survey that provides rich information on Indonesia's individuals, households, and communities. The sample data contained in the IFLS represents 83 per cent of the population in Indonesia (Strauss et al., 2016). The survey to obtain IFLS 4 was conducted in 2007 with a total of 13500 households and 43500 individuals (90 per cent of households in IFLS 1 were successfully interviewed in IFLS 4). Meanwhile, the IFLS 5 survey was conducted in 2014, where 16,204 households and 50,148 individuals were interviewed.

The data used in this study are IFLS panel data for the 2007 and 2014 periods. The reasons underlying the use of IFLS data are as follows; First, these two data waves are the

latest IFLS data, so they are relevant and appropriate for viewing conditions and the impact of climate change caused by crop failure on coping strategies undertaken by farming households in Indonesia. Second, the IFLS contained relatively complete household socioeconomic information.

The IFLS data provide information on the availability of required variables, including the types of shocks that cause crop failures faced by farmers, which are proxy variables that show the impact of climate change. The number of household samples used in this study was 3 338 farmer households. Using microdata in a longitudinal format enables researchers to obtain more consistent estimates.

Strategy and estimation model

The specifications used to study farmer household coping strategies in dealing with crop failure use the model developed by Beegle et al., (2006) and Berloffa and Modena (2013). The model was developed and adapted. The basic estimation model that is used is

$$y_{ijt} = b_0 + b_1 X_{ijt} + b_2 \, Crop \, loss_{ijt} + \varepsilon_{ijt} \, \ldots\ldots\ldots (1)$$

Where: (i) farmer household, (j) is rural, and year (t=1, …, T), and y is the outcome of concern in this study, which consists of (a) household assets, (b) livestock assets, (c) the amount of household consumption, and (d) the frequency of borrowing. Crop loss is the shock variable experienced by farming households; X$_{ijt}$ is a control set that includes the characteristics of farming households, farming characteristics, and area. In addition, ε_{ijt} is an error term.

Based on previous research, Equation (1) has the potential to cause bias if estimated using pooled least squares (Kharisma, 2017). This is due to differences in household and regional characteristics, which are unobserved, and potential endogeneity problems that can affect the outcome. The strategy undertaken to overcome the problem of endogeneity and

unobserved heterogeneity and minimize the potential for bias is to use an estimation technique with a fixed effect (FE) model (Khandker and Faruqee, 2003; Khandker, 2005; Wooldridge, 2009; Khandker et al., 2010).

The fixed effect approach eliminates unobserved heterogeneity, which is assumed to be constant over time (time in variant), so the FE approach is used at the rural level. FE at the rural level captures any differences at the rural level, which might affect the impact of crop failure and are assumed to be time-invariant. Some of the differences assumed to be time-invariant include the level of fertility of agricultural land, rainfall, and cultivation methods used by farmers. This is important because differences in farmland fertility, rainfall, and cultivation methods can affect the outcomes observed over time. Thus, these differences must be considered constant so that the potential for bias resulting in incorrect conclusions can be avoided.

On the other hand, what might happen is that farming households have other choices or decisions regarding diversification strategies and are not observed in this study. This condition can lead to overcoming endogeneity problems. Thus, systematic differences among farmer household actors may influence their decisions, such as socioeconomic and demographic factors (Islam et al., 2018). Thus, the fixed effect model used is as follows;

$$y_{ijt} = b_0 + b_1 X_{ijt} + b_2 Crop\ loss_{ijt} + \varepsilon_{ijt} + v_{jt} + \gamma_{it} \ ……..(2)$$

Where v_{jt} is the rural level fixed effect, and γ_{it} is the household level fixed effect. For the variable y_{ijt}, the outcome variable consisting of household assets, livestock assets, and consumption, the data will be transformed into natural logarithms (ln). In contrast, the borrowing frequency variable remains (no transformation to ln is carried out). This data transformation will have implications for the interpretation of the resulting coefficients. The coefficient that is the focus of attention in Equation 2 above is b_2. This study hypothesizes that

climate change, which is the proxy for crop failure, will negatively impact ($b_2<0$) household assets, livestock assets, and consumption. Meanwhile, in the outcome, the frequency of borrowing for crop failures encourages farming households to request or apply for loans to financial institutions, so the coefficient $b_2> 0$.

Results and Discussions

Data description

Based on the descriptive statistics presented in Table 1, the outcome variables that are the main observations of this study are (a) household assets, (b) livestock assets, (c) the frequency of loan application, and (d) consumption. The average household assets owned by farmers increased during the 2007 (IDR 59 900 000) and 2014 (IDR 76 700 000) periods. The average increase in farmer household assets was IDR 16 800 000. The same increase also occurred in the monthly consumption level of farmer households during the 2007 and 2014 periods, with an average increase of IDR 242 783 (increased from expenses of IDR 1 632 862 in 2007 to IDR 1 875 645 in 2014). The increase in average household assets and consumption is thought to be due to farmers' accumulated income. The agricultural produce obtained by farmers is invested in the form of household assets, and some are consumed. Investments made by households aim to act as a buffer in the long term when experiencing a shock.

Table 1. Statistical Description of Variables for 2007 and 2014

Variables	2007		2014	
	Mean	Std	Mean	Std
Household Assets (IDR)	59 900 000	37 760 000	76 700 000	48 000 000
Livestock Assets (IDR)	8 283 906	34 300 000	7 114 925	6 642 585
Frequency Loan (times)	0.280	0.827	0.376	0.954
Consumption (IDR)	1 632 862	1 276 555	1 875 645	1 357 919
Crop loss (yes =1)	0.144	0.350	0.261	0.439
Land Ownership Status (own land =1)	0.588	0.492	0.611	0.487
Land Area (m2)	4 919.91	6 698.77	5 378.02	4 035.34
Paddy (yes=1)	0.530	0.499	0.467	0.500
Irrigation (yes=1)	0.285	0.452	0.274	0.446
Age (year)	49.81	11.77	55.68	11.48
Sex (man =1)	0.889	0.313	0.932	0.250
Marital Status (Marriage=1)	0.899	0.300	0.890	0.313
Household Size (people)	4.162	1.632	3.926	1.712
Adult Household Members (people)	2.889	1.130	2.934	1.165
Education (year)	6.055	4.217	6.232	4.367
Member of Cooperation (yes = 1)	0.055	0.230	0.045	0.208
Extension Program (yes=1)	0.508	0.500	0.460	0.498
Rural (yes=1)	0.819	0.385	0.749	0.433
Observations	**1 669**		**1 669**	

Meanwhile, the average livestock assets owned by farmers decreased by IDR 1 168 981 between 2007 and 2014. For farmers, livestock is a form of saving that can be withdrawn at any time by selling it. Selling livestock is relatively easier than selling household assets (Upton, 2004; Herrero et al., 2012). The initial indications are that livestock is an asset owned by farmers and is the easiest to convert into cash or mortgage to other parties in rural areas. Loans are another outcome variable that becomes a household strategy for dealing with or responding to shocks. Between 2007 and 2014, it can be seen that the average frequency of loans made by farming households increased by 0.096. The increase in the frequency of loans made by farmers is indicated as a result of households not having enough household assets and livestock to sell and mortgage; thus, when farmers experience shock, one of which is crop failure, they apply for loans again.

On the other hand, based on the results of descriptive statistics, the average shock due to climate change as a proxy for crop failure during the 2007 and 2014 periods increased by 0.117 points. This means that the average number of farming households that have experienced crop failure has increased. It was noted that in 2007 the average crop failure was 0.280 points, increasing to 0.376 in 2014. This indication of increased crop failures was caused by El Nino and La Nina, which caused drought, floods, forest fires, and crop failures. While the main commodity cultivated by farmers based on the description of the data is paddy (53 per cent in 2007), the rest of the farmers are cultivating vegetables, fruit, gardens, raising livestock, and cultivating fish. However, in 2014, farmers who planted the main food crop (rice) decreased by 0.06. This is possible because, during 2017 – 2024, there were disasters caused by El Nino and La Nina caused crop failure or rice crop yields were not optimal. Thus, farmers try to cultivate commodities that are considered more profitable. Detailed information regarding the statistical description of all the variables used in this study is shown in Table 1.

Farmer household coping strategies facing crop failure

The results of the estimation of farmers' household coping strategies are presented in detail in Table 2. Based on the estimation strategy and model used in this study, what coping strategies will be implemented by farming households when they experience crop failure? Are the outcome variables tested in this study following theories and hypotheses? In this study, the focus of attention on the coping strategies observed when farming households experience a shock to their main income (agricultural products) is whether they will sell household assets, sell livestock assets, reduce consumption, or increase the number of loans to reduce the impact of the shock.

Table 2. Coping Strategy of Farmer Households Facing Crop Failure

Variables	Household Assets (ln)	Livestock Assets (ln)	Consumption (ln)	Frequency Loan
Crop loss (yes =1)	**-0.169****	**-1.591*****	**-0.284**	**0.158****
	(0.075)	**(0.512)**	**(0.275)**	**(0.061)**
Land Ownership Status (own land =1)	-0.148*	0.584	0.211	-0.004
	(0.080)	(0.524)	(0.244)	(0.058)
Land Area (m^2)	-0.000	0.000***	0.000**	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Paddy (yes=1)	-0.280***	0.419	0.141	-0.127*
	(0.094)	(0.503)	(0.292)	(0.073)
Irrigation (yes=1)	0.155	1.193*	0.552	0.059
	(0.103)	(0.693)	(0.366)	(0.060)
Age (year)	0.121***	-0.575***	-0.191***	0.008*
	(0.008)	(0.059)	(0.025)	(0.004)
Sex (man =1)	1.127***	-3.521**	-1.914**	0.232
	(0.292)	(1.549)	(0.780)	(0.189)
Marital Status (Marriage=1)	0.396	-1.132	0.662	-0.072
	(0.254)	(1.483)	(0.704)	(0.151)
Household Size (people)	-0.133***	0.797***	0.230*	-0.004
	(0.035)	(0.194)	(0.133)	(0.028)
Adult Household Members (people)	0.160***	-0.943***	-0.185	0.001
	(0.047)	(0.252)	(0.183)	(0.030)
Education oh HH (year)	0.208***	-1.066***	-0.449***	-0.005
	(0.028)	(0.181)	(0.097)	(0.019)
Member of Cooperation (yes = 1)	0.131	-0.050	0.470	0.281**
	(0.129)	(0.897)	(0.726)	(0.114)
Extension Program (yes=1)	0.078	0.022	0.296	-0.050
	(0.108)	(0.659)	(0.306)	(0.043)
Rural (yes=1)	-0.331**	1.543	1.356**	0.386*
	(0.167)	(1.294)	(0.638)	(0.213)
Constant	9.027***	44.987***	17.019***	-0.335
	(0.680)	(5.183)	(3.547)	(0.367)
Observations	3 338	3 338	3 338	3 338
R-squared	0.364	0.284	0.109	0.026
Fixed effect on the rural level	yes	yes	Yes	yes
Fixed effect on Household	yes	yes	Yes	yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Several empirical studies have shown that farming households' coping strategies in dealing with shocks are (1) selling household assets, (2) selling livestock assets, (3) reducing consumption, and (4) increasing the number of loans or credit (Udry, 1994; Morduch, 1995; Dercon, 2002; Liu et al., 2010; Berloffa and Modena, 2013; Sarabia et al., 2020; Padhan and Madheswaran, 2022). In general, the results of this study indicate that the shock experienced

by farming households owing to crop failure on the outcome variables tested follows the hypothesis and theory. The estimation results are presented in Table 2, which shows that crop failure affects farming households. The crop failures experienced by farming households have encouraged these households to be able to implement strategies so that economic conditions as well as their farming activities become worse.

Crop failure causes farm revenue loss, causing farmers to suffer losses. Therefore, in this study, the farmers' assumption was to sell their household assets. It can be seen that households that experience crop failure will, on average, reduce their household assets or sell these assets by 16.9 percent when compared to those without crop failure, which is statistically significant at an alpha level of 5 percent, ceteris paribus. The proceeds from selling these assets cover losses from farming activities as capital and maintain household consumption levels (Harrower and Hoddinott, 2005; Sarabia et al., 2020; Padhan and Madheswaran, 2022).

Farming households in Indonesia do the same when they experience crop failure, and to cover losses, they sell their livestock assets. For Indonesian farmers, livestock can be cashed back at any time (Kariyasa, 2005). In the results of this study, the coping strategies of farmer households when facing crop failure were statistically significant at an alpha level of 1 per cent. Households that experience crop failure will sell their assets or reduce them by an average of 159.1 per cent compared to households that do not experience crop failure, ceteris paribus. This finding is consistent with those of several previous studies (Rahut and Ali, 2018; Sarabia et al., 2020).

Meanwhile, the shock experienced by farming households did not have a significant impact on reducing monthly consumption. However, the sign or direction given by the impact of crop failure on consumption is negative, following hypothesis or theory. The underlying assumption is that crop failure does not have a significant impact on the consumption of farmer

households, because one of the coping strategies undertaken by farmer households is to use assets to cover losses and consumption costs. Thus, farming households use a portion of the sales proceeds to purchase food. In addition, farming households generally have relative food reserves that can be used when experiencing shock or crop failure. This is in line with the findings of James (1985) and Steele et al (2018) which show that when crop failures occur, farmers are forced to sell their livestock to buy food. Thus, farmers' cash income will increase, while their wealth will decrease.

The next coping strategy that farmers can carry out is to apply for a loan again or add credit to financial institutions, other farmers, or relatives. The results of this study indicate that in the face of crop failure, farmers try to make loans again. This finding is consistent with the results of previous studies (Udry, 1994; Liu et al., 2010; Pradhan and Mukherjee, 2018). The coefficient value is 0.158 and statistically significant at an alpha level of 5 per cent for the estimation model with the outcome variable loan frequency, indicating that if a crop failure occurs, the average farming household increases the loan frequency by 0.158 more than when there is no crop failure.

From these findings, it was found that the tendency of coping strategies adopted by farming households when facing crop failure was to sell assets (households and livestock) and apply for a loan again. However, the tendency of households to reduce their consumption was not statistically proven (James 1985; Steele et al., 2018). If one looks at the main trend that will be the choice of farming households in the face of crop failure, is to sell livestock assets. This can be observed from the highest coefficient value for the estimation model of the sale of livestock assets due to crop failure, amounting to 1.591. For farmers in rural areas, selling livestock assets is easier and faster than selling other household assets. Livestock assets that

become savings can be sold to fellow farmers or transferred to the livestock market (Sileshi et al., 2012; Kopparthi and Alice, 2016; Steele et al., 2018; Shewit et al., 2022)

Policy implications

The shocks experienced by farming households affected their welfare through the loss of income and assets. Shocks due to crop failure experienced by farming households, either directly or indirectly, reduce or even deplete household resources and push farm households into poverty (Kim et al., 2019; Delay et al., 2022). This research is important for policymakers to formulate policies that reduce the burden on farmers in facing the risk of losses due to crop failure (Harvey et al., 2014; Fadhil et al., 2021; Silaban et al., 2022). The government can encourage farmers to participate in the agricultural insurance program that has been running so far. The participation of farming households in insurance reduces the potential loss of their resources (Herrero et al., 2012; Harvey et al., 2014; Du et al., 2017; Fadhil et al., 2021; Silaban et al., 2022).

Insurance is a form of risk-sharing. Farmers have been reluctant to participate in agricultural insurance because they focus on paying premiums. The government can subsidize premiums from agricultural insurance programmes (Du et al., 2017; Fadhil et al., 2021). It is also necessary to consider opening up agricultural and livestock insurance opportunities, and not just focusing on rice crops and cattle.

The need for easy access to formal financing is also a consideration, as farmers have alternative financing at low costs (interest). Thus far, it has been difficult for small farmers and those in remote areas to obtain traditional sources of financing at low costs (Fadhil et al., 2021; DeLay et al., 2022; Silaban et al., 2022). Thus, small-scale farmers interact with moneylenders and middlemen, where credit or loans are provided at very high-interest rates

(Chuku and Okoye, 2009; Islam et al., 2012). Ease of access to low-cost financing needs to be continuously developed to make it easier for farmers to implement coping strategies when experiencing shocks.

Conclusion

Climate change is occurring, causing shocks to household income. One form of shock is losses due to crop failure. This condition encourages farmers to carry out coping strategies to maintain the sustainability of farming and their welfare. Coping strategies undertaken by farmers from this research include reducing assets (households and livestock) to cover losses incurred due to crop failures, as well as increasing the number of loans to financial institutions and other parties. The main strategy carried out by farming households is to sell their livestock assets. If farmers do not have livestock assets, the alternative is to sell household assets. Farmers apply for loans to other parties because they do not have livestock or household assets to sell. In addition to applying for loans, it can be used as additional capital to cover losses due to crop failure. Meanwhile, it has not been statistically proven that farmers have reduced their consumption due to crop failures.

The policy implications recommended in this study, to reduce the burden on farmers facing crop failure, include encouraging farmers to participate in agricultural insurance and livestock insurance set by the government. The ease of requirements and claims by farmers should be considered by the government to help farmers who experience crop failure. In addition, the expansion of access to financing will help farmers in their efforts to provide additional capital when they experience crop failure. Other forms of policy can also be provided, such as interest subsidies for farmers.

This study is limited to using the proxy of climate change with the occurrence of crop failure, due to floods and droughts, so in future studies it is necessary to consider other variables that can show directly about climate change, namely from the variables of air temperature and rainfall. In addition, it is also necessary to consider outcome variables to see the impact of climate change through crop failure on farmers' expenditure on health and other household assets.

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