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DOES SOCIAL CAPITAL AFFECT FARMERS' CHOICE OF CLIMATE CHANGE ADAPTATION STRATEGIES?

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ABSTRACT
Small-scale farmers in developing countries are vulnerable and negatively impacted by climate change. To enhance resilience and decrease vulnerability, studies suggest three actions: adopting new varieties, changing cropping patterns, and improving irrigation. However, the effect of social capital on farmers' adaptation strategies has been overlooked. This study incorporated social capital and other factors identifies by previous studies, into the multiple choices adaptation decision model estimation using the multivariate probit model. Personal interviews using structured questionnaire were conducted from October to December 2019 through multistage random sampling process to identify 150 chili farming households in Malang Regency, East Java, Indonesia. The findings show that climate information affects the farmer's choice to change the cropping pattern; adopting new varieties was positively influenced by subsidies and climate information; while access to cooperatives and credit affected irrigation adaptation. Therefore, enhancing farmers' social capital could help dealing with the adverse impacts of climate change.

KEY WORDS
Climate change, adaptation strategies, chili farmers, social capital, multivariate probit.

Climate change is the greatest environmental challenge with wide impacts on various sectors of the economy, human communities, natural resources, and biodiversity (Sabbaghi et al. 2020). Agriculture is inherently sensitive to climate and is among the most vulnerable sectors to global climate change hazards (Smit and Skinner 2002) and has been negatively impacted (Di Falco et al. 2012; Mendelsohn 2008; Molua 2007; Wang et al. 2014).

Chili is one of the most important vegetable crops in Indonesian (DEPTAN 2016), and its productivity in the region has been decreased because of climate change (Fadhliani 2016; Syaukat 2011). The average production of chili farmers in East Java, the largest contribution center of the national production, was reduced from 8,415 kg in 2012 to 6,856 kilograms in 2018 (Naura and Riana 2018). Moreover, in 2018 chili production was significantly decreased in East Java by 97.01% (PUSDATIN 2018)). Change in the rainy season and dry season affect chili production (Sativa et al. 2017); using household survey data, Fani et al (2020) found that increase in rainfall and drought will decrease the profit efficiency of small scale chili farmers.

Adaptation is a key factor in reducing the potential negative effects of climate change (Reidsma et al. 2010; Smit and Skinner 2002), as it has a significant impact on the productivity and income of farmers (Di Falco et al. 2011). Strategies of adaptation identified by previous research cover changes in crop patterns, improve irrigation, adopt new varieties, reduce the farm size, and change from framing to non-farming (Below et al. 2012; Masud et al. 2017; Yegbemey et al. 2013). The last two strategies focus on maintaining household income through diversification away from agriculture.

A better understanding of farmers' adaptation processes is crucial to recognizing affected individuals and designing tailored adaptation policies (Adger and Vincent 2005). Several reports find the main reasons for farmers' decisions on climate change adaptation, for instance: farming experience and education level (Fadina and Barjolle 2018); wealth, government funding for farming, access to and credit for fertile land (Bryan et al. 2009); socio-demographic characteristics and institutional accessibility (Alemayehu and Bewket 2017; Arunrat et al. 2017); socio-demographic (Below et al. 2012); and physiological factors (Le Dang et al. 2014).

Furthermore, one of the essential factors that affect adaptation strategies is social capital. Social capital is a resource created from relationship networks with a reciprocity or belief characteristic (Coleman 1990). Putnam (1993), defines social capital as social, organizational factors such as networks, norms, and values that can improve society's efficacy by allowing organized action. Bourdieu (1983) argues that all the services open to social network engagement are social capital. These services are used to retain one's status in society and also to boost one's status. Social capital is complementary and convertible to other sources of capital, including economic and cultural capital.

The importance of social capital on climate change adaptation strategy attracts researchers' attention to study it; for instance, Saptutyningsih et al (2020) found that Social capital was able to expand farmers' willingness to contribute financially to the adaptation practices by 70%. In European countries, peoples with higher social capital are more likely to have climate behavior and intention (Hao et al., 2020). In addition, farmers' access to several institutions has an important role in adaptation to change (Alam et al., 2016). Although the essential role of social capital on adaptation to climate change has been argued, there is a lack of related research on the effect of social capital on adaptation strategy in the agricultural sector. Thus, to fulfill this gap, this research tried to understand factors influencing farmers' adaptation of the previously identified strategies; particularly, the influence of social capital on chili farmers' adaptation was explored.

METHODS OF RESEARCH

This research was conducted in Malang Regency, East Java Province, Indonesia. The location was chosen purposively because chili production in Malang Regency is more advanced than other regions in East Java, in terms of the tendency of farmers to use better quality seeds (Wandschneider et al. 2019). Malang Regency is the second-largest city in East Java Province, Indonesia, which is inhabited by 866,118 people. Malang had an area of 110,06 square kilometers, lies in between 112.34'09''E to 112.41'34''E and 7.54'52'', 2 – 8.03'05 '' 11 S in East Java of Indonesia. Malang Regency with a total area (according to GIS analysis) 356 567 ha consists of 33 districts with 378 villages and 12 urban villages. Malang Regency is a horticultural production center, and the area has heterogeneous farmer characteristics in responding to climate change.

Small-scale chili farming households whose farm size was less than 0.5 hectares, and their main source of income was farming (Awazi et al. 2019; Ngango and Kim 2019) were identified as the sampling frame. The multistage sampling procedure was applied, and then the survey data were collected from October to December 2019 and obtained from 150 chili farming households[1], East Java. The survey questionnaire covered household characteristics, farmers' social capital, and determinants of their application of the adaptation strategies of the two districts chosen. Additional secondary information was gathered in journals, review papers, books, annual accounts, IPCC reports, and other related resources.

This study was analyzed by multivariate probit model (MVP) that included simultaneous models to allow for inter-relationships between multiple independent variables and multiple dependent variables. The decision-making choices were three adaptation strategies

[1] *The data were collected when the author worked at group research at Agriculture Socio-economic Department, University of Brawijaya with research group funding.*

(dependent variables), including new varieties, cropping patterns, and irrigation system adaptation. Each of the dependent variables was a binary variable with a value of one of the farmer decides to adopt it and a value of zero otherwise. This model represents the effect on each of the different choices of a series of explanatory variables and enables the direct correlation of error terms. A stable correlation framework is possible in the MVP model for unnoticeable variables. (Becker et al. 2017). The MVP model assumes that the multivariate response is an unnoticed latent variable arising from the multivariate normal distribution, provided the explanatory variables. Modeling adoption decisions using a multivariate probit method helps calculation reliability to be improved in the case of simultaneous adoption. (Mittal and Mehar 2016). Empirically the farmers' adaptation model can be specified as follows:

$$Y_{ij} = X'_{ij}\beta_j + e_{ij} \quad (1)$$

Where: *Yij* (j =1, 2, 3) are the three different adaptation strategies by the *ith* chili farmer (*i* =1, …, 150), Y_{i2} = 1, if farmer change the cropping pattern (0 otherwise), Y_{i3} = 1, if farmer develop the irrigation system (0 otherwise). X'_{ij} is a 1 × k vector of observed variables that affect the adaptation strategies β_j is a k × 1 vector of unknown parameters (to be estimated), and ε_{ij} is the unobserved error term. The vectors are socio-demographic and social capital. In this research, the author focuses on several social capitals including; cooperative participation, farmer group participation, subsidies access, and climate information access. Measurement of social capital present in Table 1.

Table 1 – Measurement of Social Capital

Social capital	Description
Subsidies	Dummy 1 if get government subsidies, 0 Otherwise
Farmer group	Dummy 1 if farmers participate in farmer group, 0 Otherwise
Climate information	Dummy 1 if farmers get climate information, 0 Otherwise
Cooperative	Dummy 1 if farmers participate in cooperative, 0 Otherwise
Credit Access	Dummy 1 if farmers have credit access, 0 Otherwise

RESULTS AND DISCUSSION

The respondent of this research consists of 150 chili farmers. Table 2 shows the descriptive statistics of variables, 53% of the sample applied the varieties adaptation, followed by crop pattern adaptation 5.02%, and irrigation adaptation 18.8%. The average household size of the sample is four people with one member who is not earning. Most of the respondents had one off-farm job. The mean age of 50.4 years suggests that the chili farmers have an advanced age. An average chili farmer has completed primary education (Class 6), although few had tertiary education, while others had no formal education. The majority of land owned by the farmers did not have a certificate with an average land area of 0.45 hectares because most farmers rent the land for farming activity. The social capital in this research includes subsidies, farmer group, climate information, cooperative, credit access. Climate information was the most social capital that farmers got followed by participation in the agricultural cooperative, farmer group, and credit access.

Results from the survey showed that 79 farmers decided to undertake adaptation strategies to respond the climate change by adopting new varieties, followed by change the crop pattern for about 75 farmers, and 28 farmers improved the irrigation system. Changing the chili varieties was the highest adaptation that was applied by the farmers. The government support to improve the new varieties that resist climate variability helps the farmers combat the negative impact of climate change. Several varieties of chili were used by farmers, including *Imola, Gada F1*, and *Tida*. These varieties have been selected for their high productivity and ability to stand with the impact of climate change (temperature, rainfall, pests, and diseases). On the other hand, improved the irrigation system was the lowest adaptation strategy applied by the farmers. This matter was not surprising, because the farmer needs more financial capital to improve the irrigation system.

Table 2 – Descriptive Statistics

Variable	Definition	Mean	Std. Dev
Adaptation strategies			
Crop pattern Adaptation	Dummy 1 if farmers change the crop pattern, 0 otherwise	0.503	0.502
New varieties adaptation	Dummy 1 if farmers adopt new varieties, 0 otherwise	0.530	0.501
Irrigation adaptation	Dummy 1 if farmers develop the irrigation, 0 otherwise	0.188	0.392
Socio-demographics			
Household size	Number of family household (individual)	3.725	1.019
Dep-ratio	Family member who not earning income (person)	0.980	0.933
Off-farm	Dummy 1 if having an off-farm job, 0 Otherwise	0.779	0.417
Education level	Farmers' education duration (year)	7.289	2.491
Age	Farmers' age (year)	50.483	9.968
Experience	Experience in farming activities (year)	29.221	10.412
Land status			
Land certificate	Dummy 1 if farmers have the land certificate, 0 Otherwise	0.087	0.283
Total area	Land total area (Ha)	0.455	0.450
Social capital			
Subsidies	Dummy 1 if get government subsidies, 0 Otherwise	0.101	0.302
Farmer group	Dummy 1 if farmers participate in farmer group, 0 Otherwise	0.329	0.471
Climate information	Dummy 1 if farmers get climate information, 0 Otherwise	0.772	0.421
Cooperative	Dummy 1 if farmers participate in cooperative, 0 Otherwise	0.470	0.501
Credit Access	Dummy 1 if farmers have credit access, 0 Otherwise	0.101	0.302

This section presents the estimated result on the factors influencing the climate change adaptation strategies by chili farmers. The regression result of the multivariate probit model showed in Table 3. The social and demographic variables have a significant effect on climate change adaptation. We found that farmers with the highest household family, education level, and age are more likely to change their crop patterns. Farmers who have off-farm jobs their less likely to change the crop pattern and adopt new varieties, but they are more likely to improve the irrigation system. This finding in line with Abu Samah et al (2019), Farmers with access to non-farms may be less vulnerable to output risk, as their dependency on agricultural income and food production is less than the median rural household. On the other farmers, experience in farm activity has a negative effect on farmers to change crop patterns and change their varieties. More experienced farmers are likely to keep their farming activity habit, including keeping their crop paten and type of varieties.

Table 3 – Parameter estimates from multivariate probit for estimating determinants of adaptation to climate change

Variable	Crop pattern Adaptation		Varieties Adaptation		Irrigation Adaptation	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Socio-demographics						
Household size	0.252	0.084*	0.006	0.965	-0.228	0.249
Dep-ratio	-0.187	0.252	-0.050	0.758	-0.091	0.627
Off Farm	-0.987	0.009***	-0.727	0.056**	1.657	0.023**
Education Level	0.137	0.012**	0.062	0.269	-0.061	0.389
Age	0.050	0.022**	0.032	0.146	-0.039	0.215
Experience	-0.060	0.009***	-0.051	0.027**	0.047	0.165
Land status						
Land Certificate	-1.674	0.002**	-2.279	0.001***	1.047	0.059*
Total Area	-0.732	0.018**	-0.370	0.224	0.311	0.334
Social capital						
Subsidies	0.306	0.503	1.962	0.007***	0.022	0.971
Farmer Group	-0.158	0.560	-0.367	0.173	0.614	0.100
Climate Information	0.784	0.048**	0.900	0.020***	0.527	0.338
Cooperative	0.269	0.310	0.386	0.135	1.190	0.001***
Credit Access	0.450	0.293	1.076	0.029**	0.989	0.020**
Cons	-2.069	0.028	-0.582	0.541	-2.253	0.157

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

Land status significantly determines farmers' adaptation to climate change. The coefficient of dummy land certificate is negative on crop pattern and adopts the new varieties. But it is positively significant on irrigation adaptation. This mean farmers with the land certificate are likely to improve the irrigation system. This finding is not surprising, land certificate indicates that the land they use in farming activity is theirs. So, farmers can renovate the infrastructure in their land. Furthermore, the coefficient of the total land area is negative at crop pattern adaptation and varieties adaptation. This result implies that farmers with the highest land area are less likely to change their crop patterns and varieties.

The result from social capital found that the government subsidies positively impact new varieties adaptation. One of government support on the agriculture sector is giving the farmers new varieties. The farmers believe the types of varieties supported by the government are more productive and resistant. According to Mulwa et al (2017), farmers' lack of trust in government support involves total crop failure. Access to climate information has a positive and significant impact on crop patterns and varieties adaptation. Farmers who have access to climate information are more likely adaptive. Farmers exposed to climate information are more likely to take drastic steps to mitigate climate change-related risks (Feleke et al. 2016). Participation in agriculture cooperative makes the farmer more likely to improve their irrigation system. Furthermore, credit access positively affects variety and irrigation adaptation. Farmers who have credit access are more likely to change their varieties and improve the irrigation system. Credit access help farmer to improve their financial capital in improving their farming activity. In line with Feleke et al (2016), they found credit access was the most influencing independent variable on farmers' adaptation to climate change.

CONCLUSION

This study examined the determinants of adaptation strategies of chili farmers, using household survey data and the multivariate probit model. Based on socio-demography results, farmers with the highest household family, education level, and age are more likely to change their crop patterns. However, farmers who have off-farm jobs more likely to improve the irrigation system. Experienced farmers are likely to keep their habit in farming activity, including keeping their crop paten and type of varieties. There are three critical findings from the paper. First, the government's subsidies play an important role in farmers adopting the new varieties of chili. This finding implies that the chili farmers believed in the government support to adopt the new varieties. There is a need for further improvement to develop new varieties to face future climate change. Second, the interesting finding is that access to climate information can be an important driver of farmers' adaptation decisions. These findings indicate the need for improved access to climate information and capacity building in rural areas of Indonesia to increase understanding of climate change issues among chili farmers. The last important result is that credit availability helps farmers to make decisions on adaptation. Such studies have major policy implications. First, the policy message from this is that substantial investment by governments in increasing and equalizing the subsidies. Second, provide climate information, especially for small scale farmers in the rural area. The last is contributing agriculture credit institutions that easily accessible by the farmers in the rural area.

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