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FARMER AWARENESS, RISK PERCEPTION AND ADAPTATION TO CLIMATE CHANGE: IS THE INDONESIANS' CLIMATE PROGRAM MAKES A DIFFERENCE?

MOH. WAHYUDI PRIYANTO[1], JANGKUNG HANDOYO MULYO[2]*, IRHAM[2], HANI PERWITASARI[2] AND ABI PRATIWA SIREGAR[2]

[1]Agribusiness Program, Faculty of Agriculture, Universitas Trunojoyo Madura, East Java, Indonesia. [2]Department of Agricultural Socioeconomics, Faculty of Agriculture, Universitas Gadjah Mada, Daerah Istimewa Yogyakarta, Indonesia.

**Corresponding author: jhandoyom@ugm.ac.id*
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Abstract: To improve the implementation of climate change adaptation and mitigation, the Indonesian government launched the Climate Village Program (CVP). However, the program's success is determined by the community's awareness and perception of climate change because these factors influence the implementation of adaptation and mitigation. This study investigates farmers' awareness, risk perceptions and adaptation to climate change in the CVP's locations. The study was conducted in Sleman and Sukoharjo Regencies, with a sample of 186 rice farmers selected using a simple random sampling method. Unpaired t-test analysis and bivariate ordered probit regression were developed in this study. The findings show that CVP farmers are more aware of dry and rainy season temperatures, wind speed during the rainy season and the uncertainty of changing seasons than non-CVP farmers, with differences in awareness (in per cent) of 16.73, 7.086, 5.851 and 14.016, respectively. CVP farmers also have a higher perception of the risk of increasing wind speed than non-CVP farmers with a perception difference (in per cent) of 11.678. The location of the CVP increases the likelihood of awareness but does not affect risk perception. Furthermore, we also found a link between awareness, risk perception, adaptation to climate change and CVP.

Keywords: Awareness and risk perception; adaptation; climate village program.

Abbreviations: CVP (Climate Village Program); DJPPI (*Direktorat Jenderal Pengendalian Perubahan Iklim*/ Directorate General of Climate Change Control); BPS (*Badan Pusat Statistik*/ Central Bureau of Statistics); BNPB (*Badan Nasional Penanggulangan Bencana*/ National Board for Disaster Management); BMKG (*Badan Meteorologi, Klimatologi, dan Geofisika/* Meteorology, Climatology and Geophysics Agency); md (Mean difference); tv (T-value); prob (probability); a-shv (Short-lived variety); a-rot (Crop rotation); a-dol (Dolomite fertilizer); a-brw (Borewell); a-adp (Total adaptation).

Introduction

Agriculture is a sector that plays an essential role in Indonesia. The agricultural sector can improve the population's food security from the production yields (Pawlak & Kołodziejczak, 2020) and reduce poverty (Balasubramanya & Stifel, 2020). However, there are many challenges facing the agricultural sector, one of which is climate change. Rice, as one of Indonesia's main agricultural commodities -the staple food of Indonesia- is threatened by climate change because it endangers productivity and food availability for the population (Hafizah *et al.*, 2020; Pickson *et al.*, 2022).

Based on climate indicators, temperatures above 35 °C affect the physiology of rice plants and the delayed change of seasons in 2050 will cause production to decline by 14% (A. Ansari *et al.*, 2021). Floods in the Philippines in 2011 due to heavy rainfall caused rough-rice production to fall by 6 million tons (Redfern *et al.*, 2012) and typhoons in the Philippines caused a loss of 12.5 million tons of rice production between 2001 and 2013 (Blanc & Strobl, 2016). In Indonesia, the total loss of rice due to climate extremes was 3.9 million ha from 2003 to 2008, with the islands of Java and Sumatra suffering 80 per cent of the losses (Lassa *et al.*, 2016). Furthermore, rising temperatures and decreased rainfall will reduce the agricultural sector's contribution to regional income (Priyanto, 2021). Climate change reduces water availability, thus threatening the agricultural sector as the main livelihood of the rural population (Bang *et al.*, 2022).

Implementing adaptation strategies is the most effective way to mitigate the adverse effects of climate change. The government has contributed by establishing the Climate Village Program (CVP), which aims to help people, particularly those in vulnerable areas, improve the implementation of their adaptation strategies (DJPPI, 2017). Areas within the administrative area of the neighbourhood association, hamlet and sub-district/village are the scope of CVP. CVP fosters multi-stakeholder collaboration and offers resources for disseminating and exchanging information about effective adaptation and climate change mitigation efforts (Pedoman Pelaksanaan Program Kampung Iklim, 2016). Until 2017, 1,375 locations were proposed as CVP locations (DJPPI, 2017). Sohail *et al.* (2021) state that climate change is closely related to many sectors, especially the agricultural sector. Therefore, government support is needed to increase the community's adaptive capacity. Through community participation-based adaptation programs, vulnerability to climate change will be reduced because people's knowledge about the environment, vulnerability and adaptation to climate change are high (Haque *et al.*, 2016).

Although CVP is a program established to increase the adaptive capacity of communities regardless of their livelihoods indirectly, CVP is expected to make farmers also implement adaptation strategies for their farming. However, without farmers' understanding of climate change and perceptions of its risks, implementing adaptation strategies will be in vain. They will not even implement the adaptation strategy. Priyanto *et al.* (2020) found that the number of adaptation strategies adopted by farmers will increase as their awareness and perception of the risks of climate change increases. These results make sense because farmers must first understand what they are facing and the impacts, then implement adaptation strategies to reduce the negative impacts (Niles & Mueller, 2016; Mase *et al.*, 2017; Ansari *et al.*, 2018). Abid *et al.* (2016) found that farmers were aware of climate change by observing extreme maximum and minimum temperature increases. Farmers believe that increasing extreme climate events due to climate change, such as floods, droughts, hotter summers, changes in the planting calendar and water scarcity are the main risks that adversely affect their farms (Abid *et al.*, 2016; Fahad & Wang, 2018).

Many studies have been conducted to determine awareness and perception of climate change risks (Li *et al.*, 2017; Asrat & Simane, 2018; Abid *et al.*, 2019; Budhathoki & Zander, 2020; Ali *et al.*, 2021) and studies on programs for climate change (Aggarwal *et al.*, 2018; Gunawati & Rejekiningsih, 2020; Nasruddin *et al.*, 2020). However, the link between farmers' perceptions and the program is not widely explored. The program's aim to improve the implementation of adaptation strategies is also influenced by public awareness and perception of climate change. Priyanto *et al.* (2021) compared the perceptions of rice farmers from CVP and non-CVP locations in Sleman Regency, Yogyakarta Province. This research complements previous research with a wider area coverage. In addition, bivariate ordered probit analysis was used to determine the effect of CVP and socio-economic variables on farmer awareness and risk perception of climate change. These results are expected to be used as a basis for policymakers to increase awareness and perceptions of farmers. In addition, it can be recommended to choose a location with farmers with high awareness and perception of climate change risks to increase climate change adaptation.

Materials and Methods

Study Area and Sampling Method

This research was conducted in Sleman Regency, Yogyakarta Province and Sukoharjo Regency, Central Java Province. In contrast to previous studies that examined society in general, we studied farmers because they are closer to the climate and are vulnerable to being affected by climate change. The research location is on Java Island, which contributes to 60% of national production. However, climate change causes more destructive droughts and floods, potentially reducing rice production by 30% by 2050 (Sekaranom *et al.*, 2021). In Yogyakarta Province, extreme climatic phenomena such as hurricanes and high rainfall intensity (leading to flooding) often occur (Sulistyawati *et al.*, 2018). A further impact is damage to agricultural land and the intensity of pest and disease attacks on plants increases (Saptutyningsih *et al.*, 2020). Meanwhile, Central Java contributes the highest rice production in Indonesia (BPS, 2022). However, some areas are classified as vulnerable due to climate change, such as rising sea levels, floods and droughts. People with livelihoods in agriculture and fisheries are more sensitive to climate change (Handayani *et al.*, 2017). Furthermore, we chose 1 regency for each province, namely Sleman and Sukoharjo. These locations were chosen because the agricultural sector in Sleman & Sukoharjo absorbed 13% and 11% of workers, respectively (BPS, 2021a, 2021b). In addition, 9 locations in Sleman and 14 locations in Sukoharjo have been proposed to be CVPs from 2012-2017.

One form of government appreciation is to give awards to outstanding CVP locations. The location is expected to be a model and can provide tangible benefits to encourage other regions to participate in these activities (DJPPI, 2017). Therefore, we chose three CVP locations in each regency based on considerations, namely 1) areas that have received CVP awards and/or certificates at the national, provincial and/or district levels and 2) locations with the largest rice fields. Furthermore, six non-CVP locations were selected from the same village, so the differences in resource conditions, culture and climate were not much different between CVP and non-CVP locations. The sample was determined using the Simple Random Sampling method in each village to obtain a total sample of 186 farmers (Table 1). Closed questionnaires were submitted to farmers about

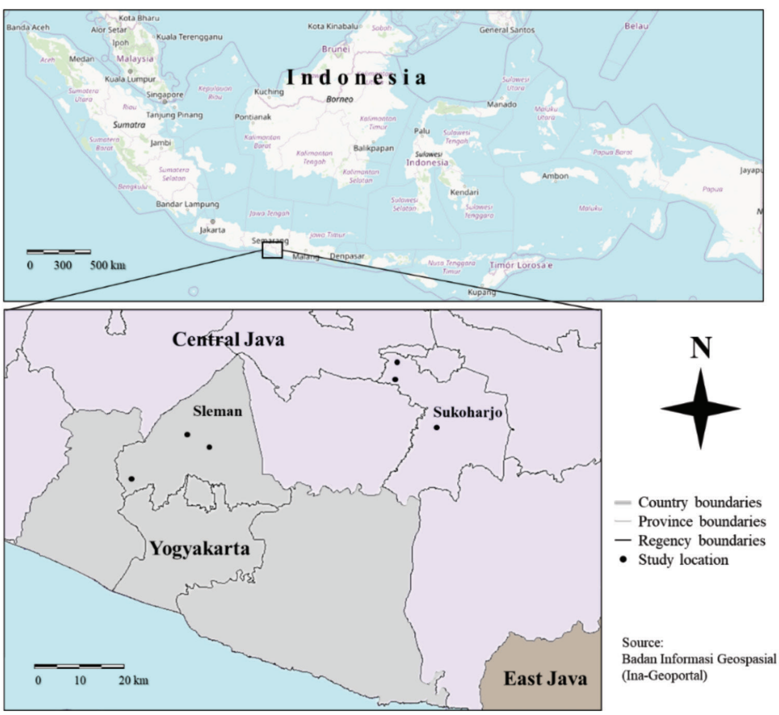

Figure 1: Study area

awareness of changes in climate indicators and the impacts caused by climate change from 2005 to 2019. Social characteristics of farmers, namely age, education, farming experience, farmer group membership, weather information and experience of crop failure, were also asked to determine their effect on awareness and perception of climate change risks. The research was conducted from December 2019 to November 2020. The research took a long time because the Covid-19 condition has hampered it since March 2020.

Climate Condition

Based on the climate change indicators from 2004-2019 in Figure 2, the climate indicators in Yogyakarta Province and Central Java Province, namely rainfall, air temperature and wind speed, show an increasing trend. The highest trend of increasing climate indicators is rainfall, with an average slope of 2.925 mm in Yogyakarta and 2.558 mm in Central Java. Likewise, Yogyakarta shows a higher trend of increasing temperature than Central Java, with values of 0.067 °C and 0.031 °C, respectively. On the other hand, the wind speed trend was also higher in Central Java (BMKG, 2020; BPS, 2022).

Data Analysis

This study uses a Likert five scale to determine farmers' responses to changes in climate indicators and perceptions of risk caused by climate change. The climate indicators in this study are temperature, rainfall, wind speed and the irregularity of the rainy and dry seasons. In the variable of awareness of climate change, changes in climate indicators are seen based on the season, namely the rainy and dry seasons. It is done to see how the tropics change with two types of seasons (Almazroui *et al.*, 2012; Chou *et al.*, 2013). Previous research has also argued that there is a difference between increasing or decreasing climate indicators based on seasons. A higher awareness score indicates an increasing change in climate indicators and vice versa. The direct and indirect impacts of changes in climate indicators on production and productivity are examined on the perception of risk. The higher the risk perception score, the more farmers agree with the impacts of climate change. Finally, we use 7 awareness indicators and 7 climate change risk perception indicators in this study.

FAs farmer responses to each indicator remain on an ordinal scale (Likert scale), it is not possible to calculate a score of awareness and risk perception by summing the indicator scores. Therefore, the Method of Successive Interval is applied so that the type of data changes to nominal data so that the indicator scores can be added up (Pradana *et al.*, 2015; Solimun *et al.*, 2017). Then we transform them into percentage values to compare the indicator scores using the following formula:

$$Idx = \frac{observe - min}{max - min} x100\% \quad (1)$$

where Idx is an index of awareness and risk perception indicators in per cent; observe is the actual indicator value of the individual; max is the highest indicator score of the sample; min is the lowest indicator score of the sample.

Table 1: Research sample

Regency	Sub-regency	Village	Population	CVP	Non-CVP	Total
Sleman	Moyudan	Sumberagung	1524	20	20	40
Sleman	Sleman	Pandowoharjo	851	20	20	40
Sleman	Ngaglik	Sariharjo	621	16	16	32
Sukoharjo	Kartasura	Kertonatan	145	6	20	26
Sukoharjo	Gatak	Sanggung	145	8	18	26
Sukoharjo	Sukoharjo	Kenep	541	22	0	22
Total				92	94	186

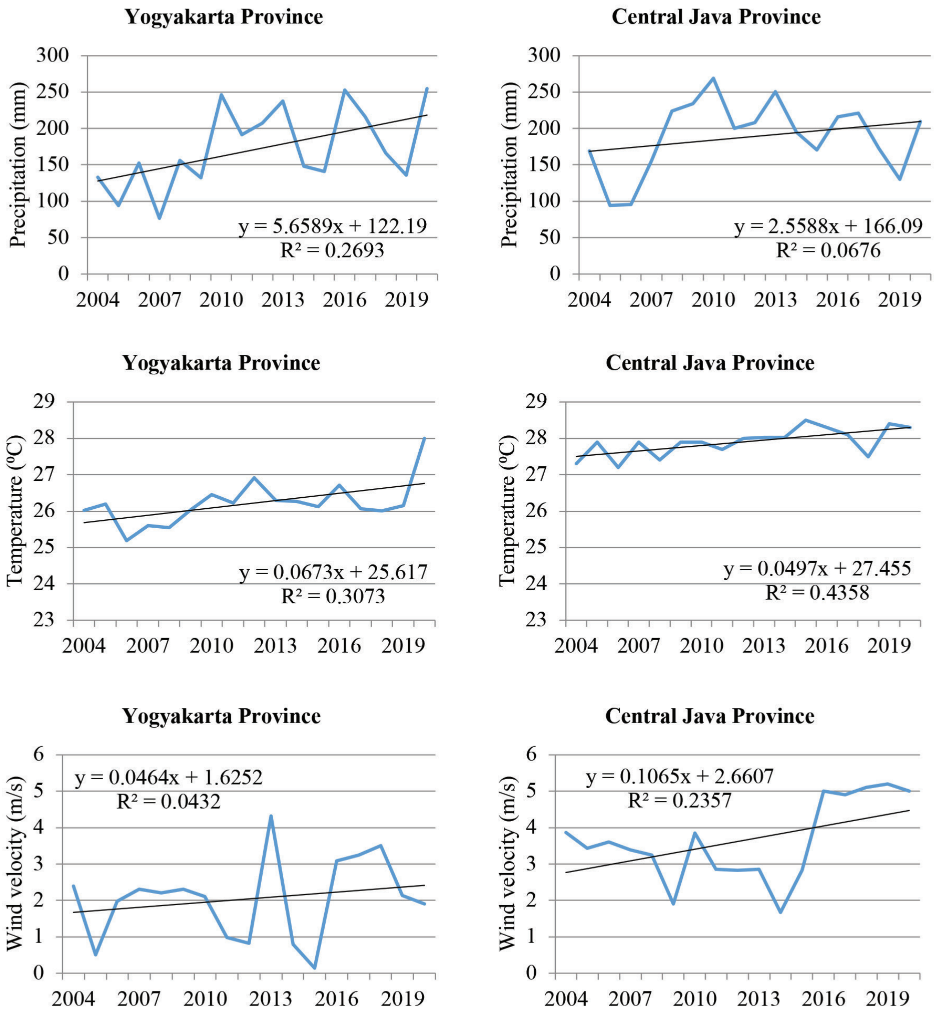

Figure 2: Climatic conditions in Yogyakarta and Central Java Province

1) Unpaired T-test

An independent two-sample t-test/ unpaired t-test analysis was conducted to determine differences in awareness and risk perception of climate change indicators between CVP and non-CVP farmers. An unpaired t-test was used to compare two independent groups. Each group is normally distributed and the variance has similarities (homogeneous), which must be met to use the analysis (Hoffman, 2019). Therefore, the Shapiro Francia test and the variance-comparison test need to be performed to determine the level of normality and homogeneity. Calculation of t-value analysis of unpaired t-test can be written as follows:

$$t = \frac{\overline{m_p} - \overline{m_{np}}}{\sqrt{\frac{s_p^2}{n_p} + \frac{s_p^2}{n_{np}}}} \quad (2)$$

where t is the t statistics; m is the mean; s_p^2 is the combined variance obtained from the weighted average of the variances of the two groups; n is the number of samples; p is the CVP group; and np is the non-CVP group.

2) Bivariate Ordered Probit Regression

Using the following formula, we created three categories for awareness and perception of climate change risk, namely very low, low, medium, high and very high:

$$Z = \frac{X-Y}{K} \quad (3)$$

where Z is the class interval; X is the highest value; Y is the lowest value; K is the number of classes/categories. Thus, the rank of awareness of climate change is 19.88-34.11% for very low, 34.11-48.34% for low, 48.34-62.58% for medium, 62.58-76.81% for high and 76.81-91.04 for very high awareness. Meanwhile, the rank of awareness of climate change risk perception is 21.01-36.81% for very low, 36.81-52.61% for low, 52.61-68.41% for medium, 68.41-84.20% for high and 84.20-100.00% for very high-risk perception.

Bivariate ordered probit analysis was applied to determine the factors that increase the probability of awareness and perception of climate change risk. This analysis is an extension of the univariate probit analysis, which only estimates the model with one dependent variable. This analysis also finds the correlation between the error terms of the two equations: awareness and perception of climate change risk (Sajaia, 2008; Greene, 2012). The bivariate ordered probit model in this study is shown by the following equation:

$$\begin{aligned} Awareness &= x_1\beta_1 + \varepsilon_1 \\ Risk\ perception &= x_2\beta_2 + \varepsilon_2 \end{aligned} \quad (4)$$

Where awareness and perception of risk is the dependent variable has three ordered outcomes, namely 1 if the awareness and perception of farmers to very low risk, 2 if low and 3 if medium, 4 if high and 5 if very high; β_1 and β_2 are exogenous variables; x_1 and x_1 are exogenous variable coefficients; ε_1 and ε_2 are error terms.

Results and Discussion

Awareness and Perception of Risks to Climate Change

We found differences in farmers' awareness and perception of climate change based on location status (Table 3). The results show that CVP farmers are more aware of climate change than non-CVP farmers. Only 1 of the 7 indicators we observed showed a higher difference among non-CVP farmers, namely the rainfall during the dry season (3). Meanwhile, 6 other indicators showed higher scores for CVP farmers, namely temperature during the dry season (1), the temperature during the rainy season (2), rainfall during the rainy season (4), wind speed during the dry season (5), wind speed during the rainy season (6) and uncertain change of seasons (7). Four indicators are significantly different between the two groups. On average, CVP farmers have a higher indicator score than non-CVP farmers, indicated by temperature during the dry season (1), the temperature during the rainy season (2), wind speed during the rainy season (6) and the uncertainty of the arrival of the rainy and dry seasons (7). CVP farmers believe that the temperature during the dry season experiences the greatest change compared to other indicators (79.89%).

Meanwhile, the score on awareness of rainfall during the dry and rainy seasons is the lowest, with non-CVP farmers having the same opinion. These results indicate that farmers' awareness of rainfall and weather information contradict each other. Weather information shows that rainfall has shown a positive trend since 2020 (Figure 2), while farmers' awareness of indicators is low or farmers perceive that rainfall has decreased. Furthermore, the wind speed indicator showed a significant difference between the two groups during the rainy season. CVP farmers are more aware of the increase in wind speed than non-CVP farmers because they are concerned about the impact of increasing wind speed. Both groups of farmers agree that the winds are stronger during the rainy season than during the dry season. Mulyana *et al.* (2018) stated that tropical hurricanes are more common in November-April or during the rainy season. CVP farmers stated that the current rainy and dry seasons are more challenging to predict than in 2005. CVP farmers realize that the late change of seasons harms rice cultivation. Previous research found that most rice varieties are sensitive to the uncertain rainy season because it affects the planting schedule, growing time and productivity (Khotasena *et al.*, 2022). This makes CVP farmers more concerned with changing seasons.

We use 7 indicators to measure climate change risk perceptions of CVP and non-CVP farmers. We compared indicators based on location status. The results showed that 6 of 7 indicators did not show significant differences between CVP and non-CVP farmers, namely indicators of rising temperature causes drought (1), the longer the dry season, the lower production (2), increased rainfall will increase pests and diseases (3), increased rainfall causes rice fields to be flooded (4), late seasonal shifts will reduce rice productivity (6), extreme climate events (floods, droughts and storms) harm people (7). There may be a significant difference in losses due to climate change between CVP and non-CVP farmers. Previous studies have shown that subjective experience with local weather anomalies such as hurricanes, floods, hurricanes, heat waves and droughts can increase beliefs and concerns about climate change. Affected communities have higher trust and concern than unaffected communities (Sambrook *et al.*, 2021). In addition, another reason is that farmers do not get this knowledge from their own experience but from other farmers. The negative effects felt by others cause farmers to feel insecure. However, one indicator was found that shows the difference between CVP and non-CVP farmers, namely the indicator of increasing wind speed will increase the fallen plants (5). Farmers' perceptions of fallen plants caused by wind speed are known to be higher for CVP farmers than for non-CVP farmers. One of the reasons is the knowledge of CVP farmers about the dangers posed by increased wind speed to their farming, supported by their awareness of increasing wind speed, especially during the rainy season. Meanwhile, non-CVP farmers assumed that weak rice rootstocks caused the plant collapse. Strong winds that led to typhoons caused damage to large areas of rice commodities, especially in the heading stage (Masutomi *et al.*, 2012).

Factors Influencing Awareness and Perception of Risk to Climate Change

Table 2 shows that the awareness and perception of the risk of CVP farmers to climate change are higher than that of non-CVP farmers, with a difference of 5.66% and 2.05%, respectively. Of the 186 farmers interviewed, 49% came from CVP locations. The average education of farmers is 9.2 years, with an average farming experience of 34.28 years. As many as 34% of farmers have

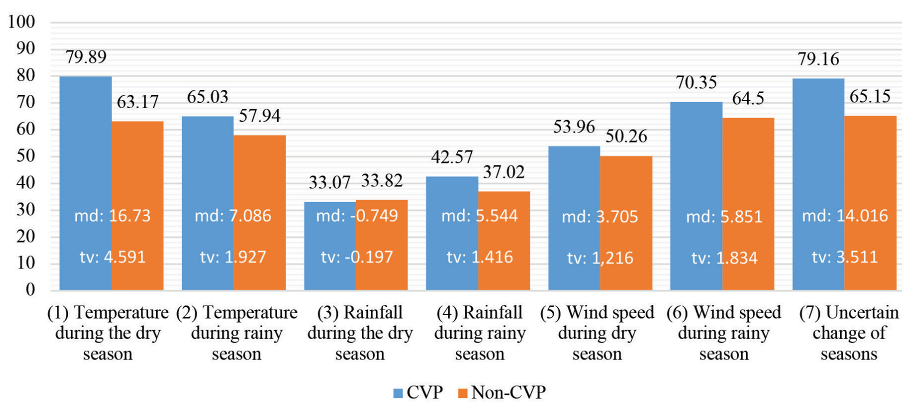

Figure 3: Farmer's awareness of climate change by location

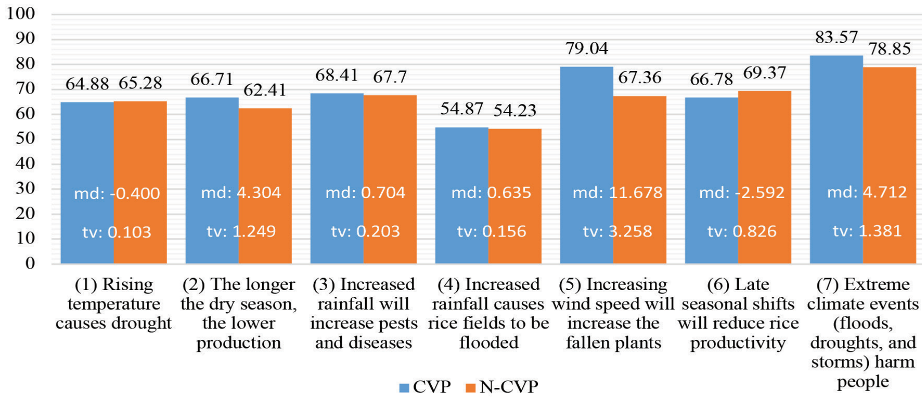

Figure 4: Farmers' perception of climate change risk by location

Table 2: The average value of the variables used in this study (by location)

Var	Definition	CVP	N-CVP	All
awr	Farmers' awareness of climate change phenomena (%)	60.58	53.12	56.81
pcr	Farmers' perception of climate change risk (%)	69.18	66.46	67.80
cvp	1 if the farmer is from CVP area, 0 if other	-	-	0.49
age	Farmer's age (years)	60.38	58.45	59.40
edu	Farmer education (years)	9.27	9.13	9.20
exp	Farmer's experience (years)	34.82	33.74	34.28
fgr	1 if the farmer is a member of the farmer group, 0 if other	0.78	0.74	0.71
cfl	1 if the farmer has experienced 100% crop failure, 0 if other	0.35	0.34	0.34
wti	1 if the farmer gets weather information, 0 other	0.82	0.55	0.68
prv	1 if the farmer is from Yogyakarta Province, 0 if Central Java Province	0.61	0.60	0.60

experienced 100% crop failure due to attacks of rats, leafhoppers, drought and collapse due to strong winds. As many as 74% of respondent farmers are members of farmer groups, whereas more non-CVP farmers are members of farmer groups. There is a significant difference between CVP and non-CVP farmers, as seen from the weather information obtained. Most respondents came from Sleman Regency, Yogyakarta (61%) because the Covid-19 pandemic hampered data collection in Sukoharjo Regency, Central Java.

Figure 3 shows the proportion of farmers by category of awareness and perception of climate change risk. We found that the majority of the sample had moderate levels of consciousness. This shows that climate indicators have not increased significantly according to farmers. The second-largest proportion is a high level of awareness of 25.27%. Furthermore, most farmers have a moderate perception of climate change risk. Farmers tend to be neutral towards statements about the negative impact of climate change on-farm production and farmer households. As many as 30.11% of farmers have a high level of perception of risk. There are still farmers with low and very low levels of awareness and perception of risk. This needs to be improved by optimizing the socio-economic factors of farmers.

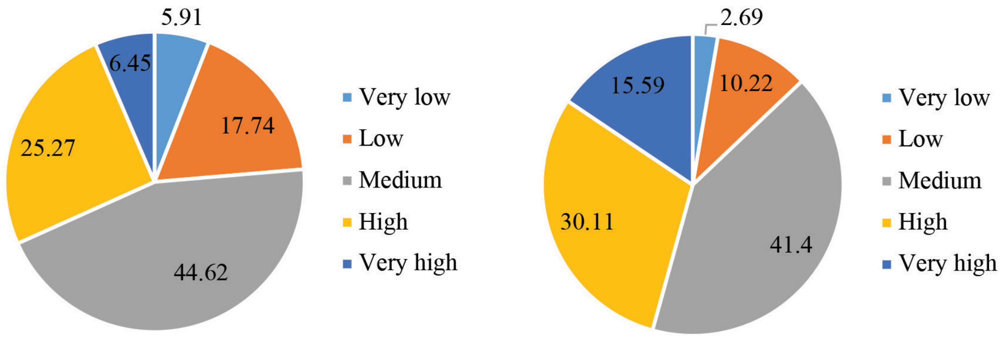

Figure 5: Farmers' awareness and perception of the risks of climate change

Table 5 shows that CVP impacts farmers' awareness of climate change, but not their perception of climate change risks. Farmers from program locations are more likely to have a positive perception of climate change, consistent with previous research that shows program farmers are more aware of climate change but have no significant impact on risk perception (Priyanto *et al.*, 2021). We assess that the program can increase farmers' awareness of climate change. Program activities, namely adapting to climate change, make people aware of what they face. It will increase their awareness of climate change. Our findings are in line with those who stated that the Climate-Smart Village program implemented in North Vietnam increased farmers' awareness of climate change. Cambers *et al.* (2019) stated that people are aware of human behaviour that damages the environment (e.g. littering), but they are not familiar with the issue of climate change. The existence of a sand watch program provides clues about the link between destructive human behaviour and climate change issues, including changes in climate indicators. We consider CVP an informal education for farmers.

In contrast to formal education, which involves the younger generation, informal education involves people of all ages and responds quickly (Filho *et al.*, 2020). Korcz *et al.* (2021) found that people who had attended informal forest education knew about climate change. In addition, because the locations are similar, there is no difference in risk perception between CVP and non-CVP farmers. As a result, the experience of being exposed to the risk of climate change is similar for farmers in both groups.

Education was found to affect awareness and perception of climate change risks positively. Higher farmer education increases the probability of having higher awareness and perception of risk. This finding is in line with Asrat & Simane (2018) and Roco *et al.* (2015). Higher-educated farmers have better information interpretation skills (Roco *et al.*, 2015). In addition, they have stronger analytical abilities by observing environmental changes and climate indicators. In the second model, the findings of the effect of perception on risk are in line with the research of Raghuvanshi *et al.* (2017). The positive effect of education refers to a more analytical mindset towards the impacts caused by climate change. Mudombi *et al.* (2014) stated that farmers with higher education have more knowledge of climate change. They have a better understanding of the negative impacts of climate change.

Furthermore, membership in farmer groups also affects awareness and perception of risk. Farmer group members are more likely than non-farmer group members to pay attention to climate change phenomena and risks. This finding is consistent with previous research (Li *et al.*, 2017; Hasan & Kumar, 2019). The farmer group forum discusses technical issues encountered during the cultivation process and serves as a forum for farmer discussion, with one topic being climate change and its impact on farmers' agriculture. According to Mustafa *et al.* (2018), there are two interaction scenarios in farmer groups: the interaction of extension workers with farmers and farmers with farmers. In the forum, they are free to exchange information about the phenomena and risks posed by climate change. Mehmood *et al.* (2022) also found that farmers who intensely contact extension workers will increase their knowledge of climate change.

Weather information positively impacts awareness and perception of the risks of climate change. It demonstrates that farmers who obtain weather information are more likely to be aware of and perceive climate change risks. This finding is consistent with previous research, which found that farmers with access to weather data are more aware of and concerned about climate change risks (Hasan & Kumar, 2019). Farmers need weather information to know what is happening now and in the future. The BMKG weather data shows the current state of climate indicators for the next day/month. This information is available to farmers via television, radio and agricultural extension channels.

Farmers in the Sleman Regency have a lower perception of climate change than farmers in the Sukoharjo Regency. The results were influenced by the differences in climatic conditions between the two regions (Figure 1). The temperature, rainfall and wind speed are lower in Yogyakarta Province than in Central Java Province. Yogyakarta farmers' perception of the risk of climate change is known to be higher than that of Central Java. According to the research sample, Yogyakarta Province and Central Java Province experienced a greater number of disasters in Sleman Regency and Sukoharjo Regency. According to BNPB (2022), from 2004-2021, the disasters occurred in Sleman (159 disasters) than Sukoharjo (109 disasters). For 18 years, the number of disasters in Sleman increased by 0.8, while the trend in Sukoharjo increased by 0.01 every year.

The rho value of 0.318 is significant at the 99% confidence level. Farmers' awareness and perception of climate change must be modelled together. Programs to increase awareness of climate change can be used to increase perceptions of climate change risks. This result is in line with the findings of (Li *et al.*, 2017), which state that awareness and perception of risk are linked. Farmers who are aware of changes in climate indicators will have a strong sense of how they will affect their farming.

The Link Between Awareness, Risk Perception, Adaptation to Climate Change and CVP

We also explored whether there was a link between awareness, perception of climate change risk, CVP and climate change adaptation. Four adaptations were found to be effective in reducing the negative impacts of climate change, namely the use of short-lived varieties, crop rotation, dolomite fertilizer and bore wells. Figure 4 shows that CVP farmers apply more adaptation strategies than non-CVP farmers. This is in line with previous research, which stated that farmers from program areas applied more adaptation strategies than non-programs (Priyanto *et al.*, 2020). This may be due to the habit of the CVP community implementing adaptation strategies in their environment. Individuals as farmers will apply climate change adaptation to their farming.

The output of the Spearman rank correlation is shown in Figure 5. We divided four adaptation strategies to assess the correlation between climate change awareness, risk perception and CVP. We also include the total adaptation strategies implemented by farmers. There is a significant positive correlation between awareness, risk perception, CVP and climate change adaptation. This shows that the other indicators will increase if each indicator increases and vice versa. This is in line with previous research where farmers with higher awareness and perception of risk have a greater opportunity to implement adaptation strategies and improve the adaptation strategies implemented. According to Mehmood *et al.* (2022), knowing the awareness and perception of farmers' risk to climate change is important because it relates

Table 3: Bivariate ordered probit regression estimation results on awareness and perception of risk to climate change

Variable	Awareness			Perception of risk		
	Coeff	**Std err**	**Z**	**Coeff**	**Std err**	**Z**
cvp	0.486***	0.168	2.90	0.051	0.168	0.30
age	-0.005	0.009	-0.53	-0.015	0.009	-1.60
edu	0.045*	0.025	1.83	0.097***	0.025	3.82
exp	0.001	0.006	0.07	0.004	0.006	0.55
fgr	0.476***	0.184	2.58	0.314*	0.186	1.69
cfl	0.030	0.172	0.18	0.213	0.175	1.22
wti	0.376**	0.188	2.00	0.715***	0.195	3.67
prv	-0.296*	0.170	-1.74	0.426**	0.173	2.46
Constant	0.329***	0.086	3.82			
rho	0.318***	0.077	4.13			
Wald chi square	31.41***					
Log likelihood	-453.396					
Obs.	186					

Note: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

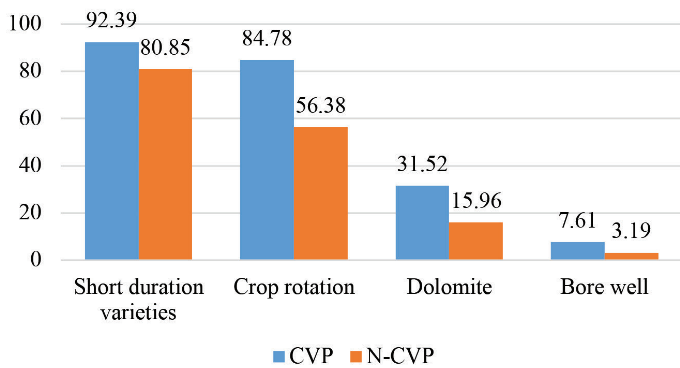

Figure 6: Adaptation to climate change

to the adaptations implemented to reduce the negative effects caused by climate change. CVP was also significantly correlated with the implementation of climate change adaptation, although it was found that different strength variations were found for each adaptation strategy. CVP shows the strongest correlation to crop rotation adaptation strategies. CVP farmers know that crop rotation adaptation will provide income diversification in one year. In addition, crop rotation increases groundwater content and efficiency; strengthens the physical and chemical properties of the soil; improves soil enzymes, fertility and soil stability; increases beneficial microbes and bacteria in the soil; reduces plant pests and diseases; and maintains ecological balance, thereby reducing the vulnerability of agricultural commodities due to climate change (Yu *et al.*, 2022). Crop rotation was closely correlated with an adaptation of short-lived commodities. Farmers can use short-lived or long-lived varieties, but they are more likely to use short-lived varieties if they want to use crop rotation techniques. Crop rotation adaptation is also strongly correlated with the accumulation of climate change adaptation. This shows that farmers who apply crop rotation tend to apply more adaptation strategies or vice versa.

Conclusion

Adaptation and mitigation strategies are the most effective ways to mitigate negative consequences. The Indonesian government established the Climate Village Program (CVP) to improve the community's ability to adapt to and mitigate climate change. However, because awareness and perception of climate change risks are prerequisites for implementing adaptation and mitigation strategies, there will be roadblocks if the CVP location is a community with low awareness and perception of risk. Therefore, we compared the awareness and risk perception of CVP and non-CVP.

The findings show that CVP farmers are more aware (significantly) of temperature changes during the rainy and dry seasons and changes in wind speed during the rainy season. Meanwhile, regarding risk perception, CVP farmers have a significantly higher perception of the risk posed by increased wind speed than non-CVP farmers. The probit-ordered bivariate analysis results showed that CVP affected awareness and did not affect perceptions of climate change risk. Furthermore, education, membership in farmer groups and weather information can simultaneously influence risk awareness and perception. The study also found that farmers in Yogyakarta were less aware than in Central Java, but had a higher perception of climate change risk.

Policymakers need to consider the findings of this study to develop existing programs and expand the CVP area. Despite our finding that CVP farmers were more aware and perceived climate change risks, their awareness needs to be increased since most farmers were at a moderate level. The role of extension workers needs to be increased in conveying information about the phenomena and negative impacts of climate change.

Our study has limitations that future researchers should address. First, we use the education variable in years so that it does not capture the effect of the stage of education such as elementary school, junior high school, senior high school, diploma, bachelor and postgraduate. Second, we did not focus on study sites based on agroecological zones (AEZs). Third, we use limited independent variables, so we suggest that further researchers explore the effect of other variables such as cellphone ownership, household size, access to credit and off-farm income on awareness and risk perception of climate change. Fourth, this study does not compare farmers' awareness and risk perceptions with meteorological data. Therefore, further researchers need to compare CVP farmers' awareness of climate change with meteorological data from the Indonesian Meteorology, Climatology and Geophysics Agency (BMKG) and then compare risk

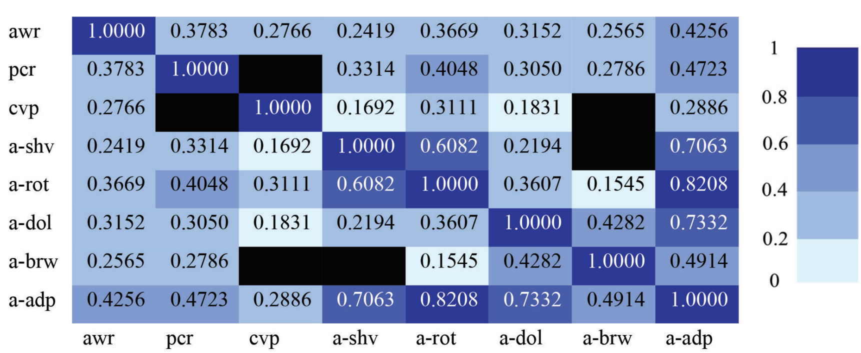

Figure 7: Correlation

perceptions with data on losses caused by floods, droughts and typhoons.

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