Adaptation of Red Upland Rice Farmers to Climate Change in Semanu District, Gunungkidul Regency

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Abstract. Farmers face high risks to the success of their production due to climate change, which occurs intensively and continuously, so red upland rice farmers in Semanu District, Gunungkidul Regency, have to adapt. The research aims to describe the adaptation of red upland rice farmers to climate change and determine the factors that influence it. The research location was carried out using purposive sampling. Respondents were defined as red upland rice farmers using a simple random sampling method of 100 farmers. Data analysis techniques include descriptive analysis, score analysis, and binary logistic regression analysis. The research results show that adaptation in farmers aged over 50 years is in the very high category. Meanwhile, farmers under and equal to 50 are included in the moderately adaptive category. Factors influencing red upland rice farmers' adaptation to climate change are land area, age, gender, education, farming experience, number of family members, and distance to market. The implications of this research provide important guidance for policy, namely tailored training for older farmers, educational programs for young farmers, and gender-specific support for women to increase sustainable food security amidst climate change.

1 Introduction

Red rice is one of the famous types of rice in the Special Region of Yogyakarta. In this case, two famous red rice types in Gunungkidul, Mandel, and Segreng, are planted as *Oryza Sativa*. Of the two varieties, the people of Gunungkidul prefer rice Segreng. This is because it is easy to cultivate it on dry land, and it can survive until harvest time. On the other hand, Segreng varieties have a shorter planting period than Mandel varieties. The emergence of red rice, especially varieties Segreng, was started by a village leader in Semanu District who planted red rice in his yard in 1940. The development of this variety can be seen through the growth of green plants on dry land so that farmers begin to develop it using seeds from Semanu and Ponjong. Therefore, varieties of Segreng became the main icon of Gunungkidul [1]

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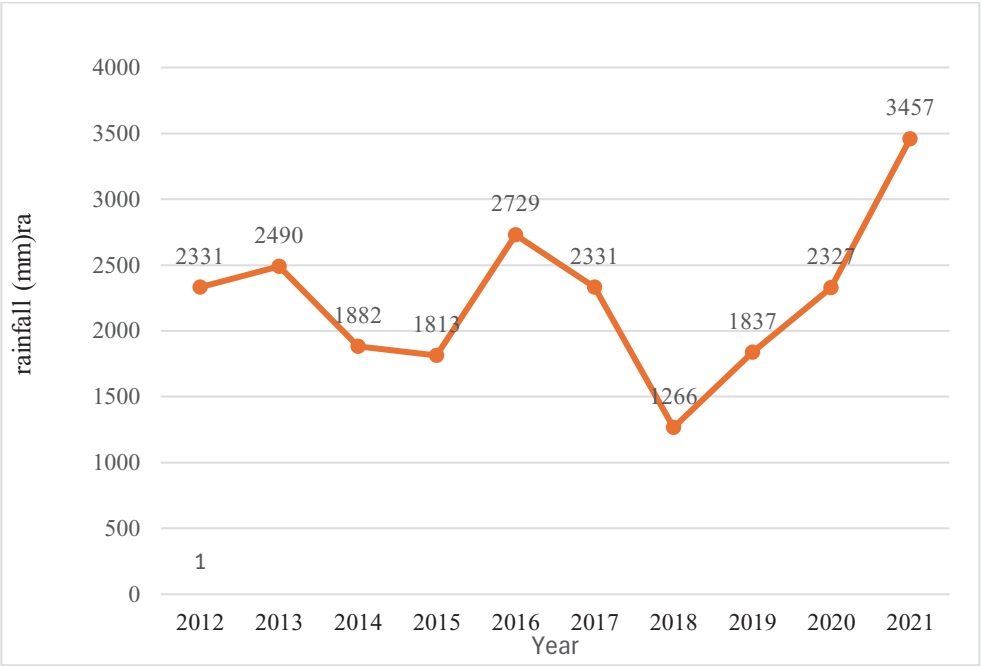

Fig. 1. Rainfall in Semanu District, Gunung Kidul Regency (mm)

In Figure 1. The highest rainfall is in 2021, with a total rainfall of 3,457 mm/year. Rainfall is often a limiting factor in agricultural activities. This is because climate change can affect the farm system from time to time. Farmers cannot predict and overcome production failures and losses caused by climate change to the sustainability of agricultural activities related to changes and shifts in rainfall patterns in the dry and rainy seasons [2]. The impact of climate change in Semanu District caused damage to the agricultural sector, such as decreased production and productivity, which will later threaten various types of food crops. The following is data on the production and productivity of upland rice in Semanu District, Gunungkidul Regency, in 2016-2021

Table 1. Productivity and production of upland rice in Semanu District

Year	Production (Tons)	Productivity (Tons/Ha)
2016	13,595	4.2
2017	13,339	4.4
2018	17,490	5.4
2019	20,984	6.4
2020	19,700	6.1
2021	18,718	5.8

Table 1 shows that the productivity and production of upland rice in Semanu District has decreased in 2021. Increased climate change, such as the frequency of extreme weather and heavy rainfall, will cause flooding. Because agricultural land is flooded by water, the rice planted will quickly rot and cause crop failure. In addition, extreme rain can reduce soil fertility because the fertilizer will dissolve in the water, so the nutrients absorbed will not be maximized. This will trigger an increase in pest attacks and diseases that affect plant physiology. In this case, farmers in Semanu District must be able to adapt to climate change. One adaptation farmer in Semanu District use during climate change is not planting rice or replacing rice food crops with crops such as corn, beans, and cassava to minimize the risk of crop failure or implementing an intercropping system on their farmland. In addition, farmers

also decide to cultivate the soil to form rice roots. A good rice root will absorb water and other nutrients to the maximum. Farmers also plant at the beginning of the rainy season, use pesticides, prepare good seeds, and increase weeding intensity. Climate change has a significant impact on agriculture. More than 58% of farmers must adapt their farming activities to climate change [3]. A better understanding of concerns and how they view climate change is fundamental [4]. In general, in cultivating a plant, the growth and development of cultivated plants are greatly influenced by genetic and environmental factors. The most important environmental factor is climate. Therefore, farmers are required to adapt to minimize damage due to the impact of climate change. This is because the severity of the impact of climate change on the agricultural sector depends on the level of adaptation of farmers in the face of climate change.

The risk of impacts from climate change is related to the adaptation carried out. Without adaptation measures, the production of key crops such as rice, wheat, and corn will decline, triggering shocks to economic welfare, deaths, health, migration patterns, natural ecosystems, and food security. The actions and adaptation choices taken and implemented at this time will determine the risks and impacts that will be faced in the future[5].

The adaptation that red upland rice farmers usually carry out in Semanu District is implementing an intercropping system to obtain varied results and using pesticides to eradicate Plant Pest Organisms attacks, increasing the intensity of weed weeding due to faster weed growth during the rainy season, making arrangements in tillage to form a rice root system, and planting at the beginning of the rainy season to support the initial growth of rice plants. The impact of climate change, such as a decrease in production and productivity of red upland rice in the Semanu District, requires farmers to be able to adapt to uncertain climate change. This study was conducted to describe the adaptation carried out by red upland rice farmers in the face of climate change and to find out the factors that affect the adaptation of red upland rice farmers in Semanu District, Gunungkidul Regency

2 Methodology

2.1 Location Determination and Sampling

The location determination was carried out deliberately or using purposive techniques. It was chosen by Semanu District, the primary originator of red upland rice, namely the Segreng variety. The sample was taken by simple random sampling and included 100 farmers.

2.2 Analysis Techniques

The analysis techniques used in this study are three analyses, namely descriptive analysis, score analysis, and binary logistic regression analysis. Descriptive analysis can help the researcher explain and describe the variables contained in the study [6]. Score analysis was used to determine the adaptation of red upland rice farmers to climate change. According to [7], score analysis is used as a benchmark for assigning values to each research characteristic through sub-variables that aim to calculate and determine the ranking. Meanwhile, the factors that affect farmers' adaptation were determined using binary logistic regression analysis. Binary logistic regression analysis or dichotomous logistics is one of the regression analyses used to describe the relationship between the response variable (Y) and the predictor variable (X). The response variable only represents the presence or absence of an event with a value (0 and 1) [8] [9] [10].

$$ln\left(\frac{\pi\,(x)}{1-\pi\,(x)}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + D_1 + D_2 + D_3$$

Where $\pi(x)$ is the probability (0 = do not do, 1 = do), β_0 is a constant, X_1 is age (years), X_2 is the experience of farming (years), X_3 is a land area ($m^{2)}$ X_4 is distance from market (km), X_5 is income (IDR), X_6 is number of family members (people), X_7 is the last education (1 = TS, 2 = Elementary, 3 = Junior High School, 4 = High School, 5 = PT), Variable Dummy D_1 is gender (0 = female, 1 = male), Dummy D_2 is searching for weather information (0 = not looking for information, 1 = looking for information), Dummy D_3 is land ownership status (0 = leased land, 1 = own land).

3 Results and discussion

In this research, it is known that there are factors that influence the adaptation of red upland rice farmers to climate change, namely age, gender, last education, length of farming, number of family members, land area, land ownership status, income, seeking climate information, distance to markets and agricultural credit.

Table 2. Characteristics of red upland rice farmers in Semanu District

Characteristics	Farmer's age ≤ 50 years		Farmer's age > 50 years	
	∑ (person)	%	∑ (person)	%
Age (years)	30	30.0	70	70.0
Gender				
Woman	9	30.0	11	15.7
Man	21	70.0	59	84.3
Last Education				
No School	2	6.7	8	11.4
SD	12	40.0	48	68.6
Junior High School	9	30.0	10	14.3
High School	7	23.3	4	5.7
Length of Farming				
≤20 years	14	46.7	0	0
>20 Years	16	53.3	70	70.0
Number of Family Members				
1-3	9	30.0	33	47.1
4-6	18	60.0	33	47.1
> 6	3	10.0	4	5.8
Land Area (m^2)				
300 – 3.200	25	83.3	42	60.0
3.201 – 6.101	2	6.7	15	21.4
6.102 – 9.002	0	0.0	2	2.9
9.003 – 11.903	2	6.7	10	14.3
>11.904	1	3.3	1	1.4
Land Ownership Status				
Rent	8	26.7	6	8.6
Own	22	73.3	64	91.4
Income				
-103.894 – 1.978.380	18	60.0	34	48.6
1.978.381 – 4.060.655	11	36.7	28	40.0
>4.060.655	1	3.3	8	11.4
Looking for Weather Information				
Not	7	23.3	20	28.6
Yes	23	76.7	50	71.4
Distance to market (km)				
1 – 3	27	90.0	62	88.6
>3	3	10.0	8	11.4

The characteristics of red upland rice farmers are stratified based on age between farmers aged less than 50 years, namely farmers aged 35 - 50 years and farmers aged more than 50 years ranging from 51 - 83 years. The length of farming is grouped into two criteria. Namely, farmers with a farming length of 6 – 20 years will be considered less than or equal to 20 years. Meanwhile, farmers who have a farming period of 21 – 60 years will be regarded as more than 20 years. Research [11] assumes that older age is related to their experience in responding to climate change on their farms. The characteristics of red upland rice farmers, which are thought to influence farmers' decisions in adapting to climate change, can be seen in Table 2.

Regarding age characteristics, it is known that most red upland rice farmers in Semanu District have an age ranging from 51 – 83 years (more than 50 years) with an average age of 62. Meanwhile, the average age of farmers is 35 – 50 years (less than 50 years), with an average age of 46. This age is directly proportional to the length of their farming, where farmers over 50 years old have a minimum of 20 years of agriculture in the face of climate change. In this case, red upland rice farmers in Semanu District have been through a climate period for at least 20 years, affecting the adaptation to climate change. This study shows that factors affect the adaptation of red-good rice farmers to climate change. The characteristics of red upland rice farmers are stratified based on age between farmers who are less than 50 years old, namely farmers who range from 35 to 50 years old, and farmers who are more than 50 years old who range from 51 to 83 years. The length of farming is grouped into two criteria: farmers with a farming length range of 6 – 20 years will be considered less than or equal to 20 years. Meanwhile, farmers who have a farming span of 21 – 60 years will be regarded as more than 20 years. Research [11] suggests that older age is related to their experience in responding to climate change in their farming.

3.1 Adaptation of Red Upland Rice Farmers to Climate Change

Adaptation is the ability of humans as living beings to adjust themselves to the environment. Adaptation is done with the aim of survival. The skills and strategies farmers apply in dealing with climate change can determine the level of resilience or resilience of farmers by adapting. Farmers can adapt as an effort to deal with the impact of climate change, which is increasingly difficult to predict and impacts life systems in areas such as natural aspects, health, ecosystems, and others. Every farmer household has an adaptive capacity to climate change. The adaptation capacity depends on the assets owned by farmers, primarily agricultural land [12]

Implementation in determining adaptation options can be a challenge for farmers. This is due to the increasingly intensive impact of climate change, so farmers must implement steps to adopt adaptation strategies. Climate change risk can be overcome with adaptation options that provide new societal opportunities. The consideration of time to be able to implement action on climate change is divided into three time periods, namely short-term (in the next five years), medium-term (within 5-10 years), or long-term (above ten years) [13]

The adaptations carried out by red upland rice farmers in Semanu District, Gunungkidul Regency, in facing climate change are the application of intercropping, the use of pesticides, better seed preparation, increased weeding intensity, arrangements in soil cultivation and planting at the beginning of the rainy season. These adaptations are expected to reduce the risks and impacts of climate change, such as yield decline and the risk of crop failure. The adaptations carried out by red upland rice farmers in Semanu District, Gunungkidul Regency, in facing climate change are the application of intercropping, the use of pesticides, better seed preparation, increased weeding intensity, arrangements in soil cultivation and planting at the beginning of the rainy season. These adaptations are expected to reduce the risks and impacts

of climate change, such as yield decline and the risk of crop failure. An overview of the adaptation carried out by red rice farmers in Semanu District can be seen in Table 3.

Table 3. Adaptation score of red upland rice farmers in Semanu District

Adaptation	Farmer's age ≤ 50 years		Farmer's age > 50 years	
	Score	Category	Score	Category
Intercropping application	3.43	Very High	3.52	Very High
Use of pesticides	2.90	Moderate	3.40	Very High
Better seed preparation	3.00	Moderate	3.58	Very High
Increased intensity of weeding	3.37	Very High	3.48	Very High
Arrangement in tillage	3.30	Very High	3.60	Very High
Planting at the beginning of the rainy season	2.04	Low	3.48	Very High
Score	**18.04**		**21.06**	
Category	**Moderate**		**Highly Adaptive**	

Based on Table 3, red upland rice farmers in Semanu District over 50 years old are categorized as very adaptive. This category shows that red upland rice farmers in Semanu District have been able to adapt themselves to climate change. Farmers over 50 years old are more aware of the impact of climate change, so they must minimize this impact by implementing adaptation. Meanwhile, farmers aged less than and equal to 50 years are included in the adaptive category. In this case, age influences the level of adaptation of red upland rice farmers in Semanu District, Gunungkidul Regency. The abilities and knowledge possessed by farmers can encourage them to minimize yield losses and the risk of crop failure. Research [11] shows that older age is related to their experience in responding to climate change in their farming. The perception of climate variability is directly proportional to the age of older farmers, and older farmers are more efficient at understanding climate variability than younger farmers. Therefore, as a farmer age, his ability to adequately describe the climate will increase [14].

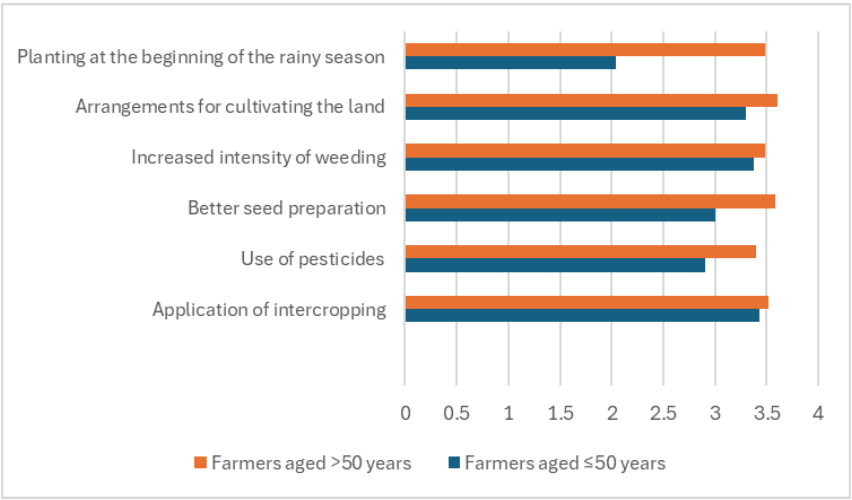

Fig. 2. Adaptation to climate change carried out by red upland rice farmers is based on the characteristics of the farmer's age

Figure 2 shows that the percentage of farmers who consistently implement intercropping is dominated by farmers over 50 years old. Older farmers are aware of land use. Besides that, older farmers think intercropping is a form of adaptation to climate change. This assumption is because the harvest results that farmers will get vary. Crops often used as intercrops are

annual crops such as corn, beans, and soybeans. Frequently changing climatic conditions mean farmers face high risks to their production's success. So, farmers apply an intercropping system to get more than one variety of harvest [15] [16].

Red upland rice farmers carry out planting at the beginning of the rainy season as an initial anticipation [17]. Red upland rice farmers in Semanu District know that their land requires sufficient water for the initial growth of rice plants. Farmers who are over 50 years old understand more about the impact of climate change by planting at the start of the rainy season. On rainfed dry land, water availability is not guaranteed. Therefore, farmers are aware of the dependence of their agricultural land on rainfall for the initial phase of rice plant growth [18]. Red upland rice farmers in Semanu District hope the harvest will be maximized by planting at the start of the rainy season.

Meanwhile, most farmers aged less than and equal to 50 years have never planted at the start of the rainy season. Their limited experience is a significant factor in dealing with climate change. Farmers do not understand how to minimize the risk of yield reduction and crop failure, or they even follow other farmers. If other farmers plant, they will also plant.

The use of pesticides is one of the things farmers commonly do to reduce the impact of climate change by minimizing pest attacks. The percentage of farmers who always use pesticides to adapt to climate change is dominated by farmers over 50 years old. Farmers over 50 years old are included in the very high category. So, farmers can adapt to using pesticides. This is based on the increase in pest attacks when climate changes. Red upland rice farmers in Semanu District use pesticides to eradicate pests to minimize yield losses and the risk of crop failure. Climate elements such as rainfall and humidity can directly or indirectly affect the growth of rice plants and pests. Farmers who are over 50 years old have a better understanding of the types of attacks that attack rice plants.

3.2 Factors Affecting the Adaptation of Red Upland Rice Farmers

Adaptations made by red upland rice farmers in Semanu District, Gunungkidul Regency, to face climate change include the application of intercropping, use of pesticides, better seed preparation, increasing the intensity of weeding, regulating land cultivation and planting at the beginning of the rainy season. These adaptations are expected to reduce the risks and impacts of climate change, such as yield reduction and the risk of crop failure [19]. The factors in farmers' decisions to adapt to climate change were analyzed using logistic regression. The first step carried out by the Goodness of Fit Test is to test the suitability of the model to the data. The method can be used to test the suitability test of the logistic regression model, the Hosmer-Lemeshow Test [20] [21]

Table 4. Goodness of Fit Test (The Hosmer-Lemeshow Test)

Adaptation	X^2 (Chi square)	df	P Value	-2log likelihood	Nagelkerke R Square
Application of Intercropping	7.424	8	0.492	41.198	0.228
Uses of Pesticides	3.185	8	0.922	49.527	0.486
Better Seed Preparation	4.667	8	0.792	49.864	0.403
Increased intensity of weeding	6.986	8	0.538	48.191	0.255
Arrangement in tillage	3.996	8	0.858	25.871	0.394
Planting at the beginning of the rainy season	7.583	8	0,.475	74.390	0.485

In Table 4. the values are obtained through the *Hosmer and Lemeshow test* tables (chi-square, degree of freedom (df), and p-value) and the *summary model* tables (-2log likelihood, cox & snell R square, and Nagelkerke R square). *The summary model* is used to show the ability of independent variables to explain dependent variables. According to [22], *the*

summary model is only used as an approach value. For example, the *value of -2 log-likelihood* in the planting model at the beginning of the rainy season shows that by entering independent variables, there has been a change in the parameter assessment with a value of 74.390. Meanwhile, the value of *Nagelkerke R Square* in the planting model at the beginning of the rainy season was 0.485, indicating that the independent variable's ability to explain the dependent variable was 48.5%, and the remaining 51.5% was another factor outside the research model. Then, the *Hosmer and Lemeshow test* table, commonly known as *the goodness of fit,* is used to determine whether the model used appropriately explains the research variables. Table 3 shows the Fit model because the calculated chi-square value is smaller than the table chi-square value (15.51) with degree of freedom 8, and the p-value is more significant than α =5%

Farmers can apply intercropping as a form of adaptation to climate change to minimize the risk of crop failure. The plant varieties are planted by farmers in Semanu District, Gunungkidul Regency, in addition to red upland rice, namely corn, beans, and soybeans. Research [23] [16] said that plant varieties were positively correlated with farmers' adaptation actions. According to [15] noted that intercropping is a system used by farmers in farming by using two or more different types of crops at the same time on one land

Pesticides are chemicals that farmers usually use to kill pest attacks. Currently, farmers need pesticides. Farmers consider pesticides a necessity and a lifesaver in minimizing the risk of crop failure caused by the climate. Research [23][24] says that adaptation measures for climate change mitigation, such as increasing the use of pesticides and chemical fertilizers, can be carried out by farmers to reduce the impact of climate change

Increasing the intensity of weeding is one of the ways that farmers usually do it in dealing with weeds. Weed control must be carried out to create optimal growth for the growth of the main crop, namely rice. Generally, weeds grow faster in the rainy season due to the humid temperatures. Farmers can increase the intensity of weeding to adapt to climate change. According to [25] said that weed control is carried out to avoid competition with the main crop, which can cause

Red upland rice farmers usually follow regulations for cultivating the soil in the Semanu District to form strong rice roots. In addition, farmers decide to cultivate the soil to adapt to climate change and minimize the occurrence of landslides due to the slope of the land owned by farmers. According to[26], the stages of the soil tillage process differ between sloping land and flat land. In addition, land cultivation in the dry season will be more complex, making the process longer for the soil to become fertile. Meanwhile, the soil will be easier to cultivate during the rainy season, but the risk of landslides will increase.

Planting at the beginning of the rainy season is one of the ways that farmers do it as a form of anticipation in facing climate change. Gunungkidul Regency is a barren area that relies only on rainfall for its agricultural activities. Therefore, farmers consider planting rice at the beginning of the rainy season a blessing because water needs will be met for rainfed moorland. The fulfilment of water needs or availability for a plant, especially rice plants in rainfed moorland, depends on the beginning and the rainy season's length. Research [18] says that plant cultivation depends on sufficient water flow. Planting adaptation during the early rainy season is one way that farmers can do [27]

Factors influencing farmers' decisions to adapt to climate change include age, farming experience, land area, number of family members, gender, distance to market, seeking information about climate, and land ownership status. The adaptations made by farmers to face climate change include the application of intercropping (Y1), use of pesticides (Y2), better seed preparation (Y3), increasing the intensity of weeding (Y4), regulating land cultivation (Y5) and planting at the beginning of the rainy season (Y6). The results of estimating factors that influence climate change adaptation can be seen in the regression coefficient value table (Table 5).

Table 5. Regression coefficient value (β)

	Y1	Y2	Y3	Y4	Y5	Y6
Age	-0.011	**0.218****	0.111	-0.045	0.150	0.018
Farming experience	-0.015	-0.092	-0.041	**0.094***	-0.176	**0.134*****
Land Area	**0.001***	0.001	0.001	**0.001***	0.001	0.001
Distance to market	0.633	-0.437	0.066	**-0.661***	-0.816	0.016
Income	0.001	0.001	0.001	0.001	0.001	0.001
Number of family members	0.130	-0.165	-0.330	-0.202	**1.208***	-0.036
Last education	1.133	0.445	-0.389	-0.241	**2.190***	0.292
Gender	-0.051	**1.872****	**2.519*****	0.975	0.823	0.912
Search for weather information	-1.190	1.262	0.443	0.447	1.548	0.201
Land ownership status	0.890	0.682	0.041	0.628	0.755	-5.582

Note: *Significance at the level of 10%; **Significance at the level of 5%; Significance at the level of 1%

Table 5 and Table 6 show that the age variable has a significant positive effect on climate change adaptation with an odds ratio value for age of 1.305 and a regression coefficient value of 0.218. This value shows that the older the age of the red upland rice farmer, the greater the possibility and readiness of the farmer by 1.305 times to face climate change by using pesticides. Research [28]assumes that older age is related to the experience they have in responding to climate change on their farms. This is because the experience that farmers have provides many references to past climates so that calculations in taking farming risks are very important to do considering the limited capital that farmers must adapt to climate change. For this reason, young farmers must learn more from previous farmers and increase informal education about climate change adaptation so that they can be more adaptive in facing climate change.

Table 6. Odd ratio value (Exp (β))

Variable	Y1	Y2	Y3	Y4	Y5	Y6
Age	0.989	1.305	1.117	0.956	1.162	1.018
Farming experience	0.985	0.927	0.960	1.098	0.684	1.144
Land Area	1.000	1.000	1.000	1.000	1.000	1.000
Distance to market	1.883	0.777	1.068	0.516	0.442	1.016
Income	1.000	1.000	1.000	1.000	1.000	1.000
Number of family members	1.139	0.911	0.719	0.817	3.348	0.965
Last education	3.105	7.334	0.678	0.786	8.934	1.340
Gender	0.950	3.965	12.420	2.651	2.277	2.488
Search for weather information	0.304	1.753	1.557	1.564	4.702	1.222
Land status	3.435	3.608	1.042	1.874	2.128	0.582

Farming experience can reflect farmer skills. The farming experience variable has a positive effect where the longer the farmer grows red upland rice, the longer the farmer grows red upland rice the greater the opportunity for farmers to respond to climate change adaptation. The resulting odds ratio value is 1.098 which has a positive sign. This shows that the longer farmers run their farming business, the possibility of adaptation will increase by 1,098 times. This is because farmers with longer experience tend to know more about climate events in the past so they can assess and adapt their agriculture to climate change [4][29]

Land area is one of the most critical factors that can affect the productivity that farmers will later produce. The larger the land area farmers own, the more results will be obtained [30]. The coefficient value of the land area variable has a positive sign, indicating that the land area variable has a significant influence on climate change. The larger the land a farmer

owns, the greater the farmer's opportunity to intercrop at one time. Farmers are aware of the use of land that can be planted with several types or varieties of plants in one field to produce varied harvests. Apart from that, the larger the land owned by farmers, the higher the farmer's awareness of increasing the intensity of weeding by one time. The larger the land owned, the greater the opportunity for farmers to adapt to climate change [31] [23] Farmers who have land area of less than 1000 m^2 can form large farming groups so they can adapt together to climate change

Table 5 and Table 6 show that the coefficient value of distance to market on farmers' opportunities to increase the intensity of weeding has a negative sign. This shows that farmers who are close to the market will increase the opportunities for red upland rice farmers in Semanu District to be able to adapt to climate change by increasing the intensity of weeding by 0.516 times. Market distance can be used as a means of information. Therefore, farmers who have houses close to the market will more often exchange information regarding the interests of the farming business they run or regarding climate change. The research results are in accordance with research [4] which shows a negative coefficient which indicates that farmers located close to local markets have more opportunities to adapt to climate change compared to farmers who are located far from markets.

The number of family members can affect farmers' adaptation, as shown in Table 5. The coefficient of the number of family members is a positive sign in cultivating the soil. This indicates that the more members there are in one farmer household, the more likely there is regulation in cultivating the land as a form of adaptation 3,348 times. According to research [30], the number of family members influences the availability of labour that can be used in farming. Farmer households with many family members will provide more labour than farmer households with few family members.

Education influences red upland rice farmers in Semanu District to regulate land cultivation as a form of adaptation to climate change. This is shown by the Odds ratio value in the education variable which shows a positive value which indicates that the higher the level of education obtained by the farmer, the greater the farmer's awareness of being able to use pesticides as a form of adaptation to climate change by 8.934 times. This research is in accordance with [32] who say that higher education will create mature thinking in responding to the surrounding environment. Research [33] states that recent education has a real influence on adaptation to climate change. The higher the level of education obtained by farmers, the greater the farmer's chances of paying adaptation costs.

The gender variable shows a positive coefficient on pesticide use and better seed preparation. This shows that male farmers are more adaptive in facing climate change because male farmers are more receptive to information than female farmers. The lack of information available to women farmers about the climate may hinder them in dealing with the impacts of climate change. Table 5 shows that male farmers will increase the opportunity to use pesticides by 3.965 times and the opportunity to prepare better seeds by 12.420 times to deal with climate change. Male farmers will tend to be adaptive [34]. Apart from that, research [35] also states that male farmers can reduce the possibility of crop failure because male farmers are responsive to climate change.

4 Conclusion and recommendation

The study on the adaptation of red upland rice farmers to climate change in Semanu District, Gunungkidul Regency, reveals significant insights into how farmers cope with the impacts of a changing climate. The findings indicate that factors such as age, length of farming experience, land area, gender, education level, and the number of family members play crucial roles in determining the farmers' adaptation strategies. Older farmers are more adaptive, leveraging their experience to implement measures like pesticides, better seed

preparation, and increased weeding intensity. The larger the land area, the more opportunities for farmers to adopt practices such as intercropping and enhanced weed control. Additionally, male farmers and those with higher education levels are more likely to adapt to climate change effectively.

There is a need for education by developing climate field schools by the Department of Agriculture and Food, the Agricultural Extension Agency in collaboration with the Meteorology, Climatology, and Geophysics Agency (BMKG) to support sustainable farming planning so that farmers do not only rely on their farming experience in facing climate.

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