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Risk Analysis and Strategy of Rice Farmers in Swampland in the Face of Climate Change Impact (Case in South Kalimantan Province-Indonesia)

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Abstract

The impact of climate change does not only affect the production aspects but also on household income and other socioeconomic aspects. The research aims to determine the household economic behaviors of rice farmers in decision-making with relation to the production risks due to climate change and determine the farmer's adaptation strategies in the face of climate change. The approach taken is the production risk analysis using the coefficient variance. The result shows that the farmers' behavior to manage rice farming in the tidal area has neutral risk behavior. This means that if there is a risk or possibility of risk recurrence towards rice farming, thus the decision maker (farmer) still does not reduce or enlarge the scale of their business. Adaptation strategies adopted by farmers in swampland consists of short, medium and long term strategies. The improved adaptive capacity on farm level should be through planned adaptation whose development is conducted by the government to be synergistic and rely on autonomous adaptation that has been a tradition in the farmers community.

Keywords:
Swampland, Risk, Farmers' adaptation, Climate change

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INTRODUCTION

Climate change is almost certainly one of the most important development challenges faced by every country in the 21st century. Global warming has cause more unstable climate, such as changes in rainfall pattern and increased frequency and intensity of the extreme weather events; and it has led to increase the average of global sea level (ADB, 2009; Finger, and Schmid, 2007). The threat to the food agriculture sector due to the impact of climate change, of course, occur in the centers of swampland rice in various areas of Indonesia, including South Kalimantan (Makki and Ferrianta, 2012). The impact of climate change on rice farming was not only affected the production aspects, but also on household income and other socio-economic aspects. This matter evident when there is flood that hit North Hulu Sungai Regency as the center of food production in the swampland in 2008; the rice production on that regency is decrease by 22% due to crop damage (Daily of Banjarmasin Post; on June 2008). Economic growth in South Hulu Sungai is decrease due to the growth of agricultural sector contracted -1.52 in 2010 due to flood in the swampland.

Since the impact of climate change on swampland environment in South Kalimantan is increasingly felt the influence during the last six years; the effort such as policy both anticipation and mitigation implemented are still reactive; temporary; instantaneous, partial and tend to be oriented project so that it does not touch the problem root and not related (Makki *et al.,* 2009). If it allowed, not only affect on food security, but also a process of impoverishment that will increase the number of poor people. One effort that can be done to reduce and anticipation the impacts are adaptation of climate change through adaptation strategies in agriculture business management in swampland by farmers and economic strengthening their household by first performing on risk analysis.

The research article aims to determine the household economic behavior of rice farmers in swampland in terms of decision-making in relation to the production risks due to climate change and farmers adaptation strategies in the face of climate change. The approach taken is the production risk analysis using the coefficient variance.

MATERIALS AND METHODS

Data and sampling techniques

This research is conducted in two swampland agro-ecosystem in South Kalimantan both non-tidal swampland and tidal swampland. To represent the agro-ecosystem of tidal swampland is selected two regency namely Kuala Barito Regency and Banjar Regency. Represents the type of non-tidal swampland is selected North Hulu Sungai. This regency is purposively selected with the consideration that the area of swampland is the largest in South Kalimantan.

Representing the agro-ecosystem of tidal swampland is selected two regency namely Kuala Barito Regency (Batola) and Banjar Regency. Each regency selected two sub-districts purposively, that is Barambai District and Cerbon District in Batola Regency, and Aluh-Aluh District and Beruntung Baru District in Banjar Regency. The total number of villages selected in this research is 12 villages. From each of these villages, the farmers sample will be determined by proportionate random sampling. Overall the total samples of farmers as the primary data source is 240 respondents consisting of 180 farmer respondents as the sample for tidal swampland type, and 60 farmer respondents as the sample for non tidal swampland. The main requirement of sample is these farmers conduct rice farming of minimum four plant season in swampland.

Data analysis

The design of this analysis model attempted to determine the risk posibility that will occur over the use of production input in the certain farm land size. Particularly relevant to this analysis is shown with reference to the empirical model of production risk analysis in accordance with the rules of Singh (1980). The benefit of this model is to identify the subjective probability of each farmers sample on rice farming activities in tidal land in different risk situation. General design model used in the analysis of these data presented in Table 1.

The next analysis stage, after sought opportunities to each farmer example, then proceed with the cash flow analysis as recommended by Horne (1993).

To calculate and measure the magnitude of the

Table 1: Calculation model of subjective probability and possible of cost Incurred to purchase input production in accordance with the circumstances experienced by farmers.

Situations	Subjective Probability	Possibility of Input Cost (IDR/Hectare)			
		X1	X2	X3	Xn
A	P (A)	ΣX1A	ΣX2A	ΣX3A	ΣXiA
B	P (B)	ΣX1B	ΣX2B	ΣX3B	ΣXjB
Expectation Value	ΣP (n)	ΣX1n	ΣX2n	ΣX3n	ΣXijn

Description: A = normal situation B = Flooded (one of the impacts of climate change)

production risk possibility that will occur in instances on sample farmer group, followed by calculating the probability distribution of net cash flow, by first calculating the standard deviation as:

$$\vartheta_x = \sqrt{\Sigma(R_{xt} - E(R_{xt}))^2 P_{xt}} \quad (1)$$

Where, Rx_t = *net cash flow* of sample farmer of the x at t time

Px_t = probability that occur in the net cash flow of sample

Farmerof the x at t time

$E(R_{tx})$ = value expectation of *net cash flow* at t time

Expectation value of the net cash flow in t period sought by the general formula:

$$E(R_{xt}) + \Sigma R_{xt}.P_{xt} \quad (2)$$

The next step is to compare sample group of farmers who have larger standard deviation, which can be used as indicator which can states the spread magnitude of rice production probability that earned by sample farmers. To decide the degree of risk size between the samples farmers compared, it can be determined by calculating the coefficient variance (CV,) by:

$$CV_2 = \vartheta_x / E(R_{tx}) \quad (3)$$

Where: CV_2 = coefficient variance in the sample farmers of the x

θ = standard deviation of the sample farmers of the x

E (R_{tx}) = expectation value of the net cash flow at t time and the sample farmers of the x

In this case, if the value of coefficient variance (CV) of sample farmer-x in instances greater than the others, then the sample farmers decided to have higher degree of risk (Harwood *et al*., 1999; Horne, 1983). The coefficient variance is the standard deviation distributed to each sample farmers and it can be expressed in percent. The larger the CV value, the greater the risk variability that will occur.

RESULTS AND DISCUSSIONS

Production risk analysis of rice farming in swampland

Rice farming in swampland in particular tidal is faced with the problem of production risk. Indication of production risk of rice farming in the tidal area is indicated by fluctuation or the amount output variation generated due to the possible use of input production under normal condition and under condition of high rainfall, thus also causes the income fluctuation and profits shown on farming the cash flow. Input use and the expenditure of production cost in the tidal area can be seen from the comparison in normal condition and high rainfall condition.

In addition to the output variation due to input variations and variations in income; discussion of risks also relates the occurrence of an event of the probability that can be measured. In this research, the probability that lead to failure or risk based on the subjective probability of each season the assumed value. Basic assumption is the possibility of production failure or loss possibility due to lack of farmers' ability to predict the changes of weather and climate. Because there are two comparison of subjective probability between the normal situation and situation of rice farming faced heavy rainfall, then when the one probability value is X then the the other probability is (1-X). In the case of rice farming in swampland, especially tidal area; the probability of normal situation rated 0.6 so assuming the other value is only 0.4.

The existence of the probability value, then it can be done the production risk assessment which can be calculated using the Coefficient Variance (CV). CV is the ratio of standard deviation with return expectation value of rice farming in the expected net cash flow derived by the average farmer. With the size of the CV, business activity analysis has been carried out with the same size, which is the risk for every net cash flow.

The result of the risk analysis of rice production in the tidal area gets the value of coefficient variance (CV) of 0.45 to 0.48 or can be expressed in a percentage of 45% - 48%. In other words, the risks covered by rice farmers in the tidal area especially in Banjar Regency is 45% - 48% of the value of return (net cash flow) obtained. This means that every IDR 1 return (net cash flow) received by rice farmers in the tidal area will get risk of IDR 0.45 to 0.48. This value is the ratio of the standard deviation of the net cash flow (in normal climate and climate with very high rainfall).

When linked with the farmer's behavior in two different seasons, then the CV value of 0.45 to 0.48 indicates that the rice farmers in tidal area in Banjar Regency have neutral risk behavior. It is appropriate that proposed by Debertin (1986). CV value is relatively closer to the CV value when farmers face high rainfall and also similar to the normal situation. This means that if there is a risk or possibility of risk recurrence towards rice farming, thus the decision maker (farmer) still does not reduce or enlarge the scale of their business. The data shows that the area of rice farming between the seasons is not different. This matter due to rice farming is a business that seems to "shall" be implemented and as much as possible the wetland should not suffer harvest failures, no matter how great the risks faced.

Strategies of farmers adaptation and anticipation of climate change

The agricultural sector is highly vulnerable towards climate change because it affects the cropping pattern, time of planting, production, and quality of results. Thus the necessary effort is relatively fast and able to reduce the negative effects of climate change. One effort that can be done through adaptation of rice plants by local farmers or farmer groups.

The general target of adaptation is to minimize vulnerabilities, develop resilience, and it developing them if the circumstances allow. Vulnerability of farmers to climate change is determined by the interaction potential impacts of climate change and adaptation capacity of farmers (Boer, 2007). The potential impact is the resultant of farmers from sensitivity farmers and exposure due to variations in sharp climate. On the other hand, farmers' adaptive capacity is determined by the internal conditions of farmers and external supporting factors. Internal conditions include the farmers' knowledge and mastery of farming technology, the ability of capital, and managerial skills, while the most important supporting factors are the availability of infrastructure, innovative technology packages, and institutional.

According to Boer (2007) and Irianto (2010); adaptive capacity is defined as the degree of adjustment that occurs in practice, process, or structure that can alleviate or overcome potential damage / loss or benefit from the opportunities that may exist. Factors that influence the adaptive capacity are socioeconomic, technology, infrastructure, and government policy factors.

The situation and condition of the factors that influence the adaptive capacity are vary so adaptive capacities between regions, between communities, and even between individual farmers also vary. The implication, critical nodes of increase strategy of adaptive capacity between regions, or between communities also vary. Information about diversity and the factors that influence it is very useful to support policy formulation, programming and implementation strategies of adaptation towards climate change (Brooks *et al.*, 2005).

Policy effectiveness and adaptation program are not only determined by the accuracy design and its instrument but also determined by the accuracy of the strategy adopted to implement them (FAO, 2007; Finger and Schmid, 2007; IPCC, 2007). This is an implication of the following conditions. Effectiveness of adaptation is determined by a combination of: (i) the selected instrument, (ii) the methods applied, (iii) the level and quality of public participation (target groups), and (iv) the provision efficiency of supporting factor (especially infrastructure and institutional), and (v) the consistency of policy and programs.

Although the shape or type is varied but the target of adaptation to climate change in principle is to minimize the vulnerability, build resilience, and develop the ability to utilize the favorable opportunity of the situation and the conditions posed by climate change (Brooks and Adger, 2005). Vulnerability is the degree of easy or not subjected, damaged, lost, or weakens its existence. Unlike the vulnerability, resilience refers to the design ability to survive, recover, or even evolved from conditions created from the result which appear related to climate change (ECA, 2009; Harmony, 2006). Keyword to address this challenge is to strive for the vulnerability of farmers to unfavorable climate conditions can be reduced. In other words, farmers should be conditioned to be more resistant, robust, and resilience to confront the climate change.

Historically, every individual or community of farmers has always faced with the challenges to adapt with their environment, either physical or socio-economic environment. Therefore, the essence of policy and adaptation programs should be reoriented to accelerate the process of improving their adaptive capacity. Therefore, the main actor adaptation to climate change in the agricultural sector is the farmer, thus the forms of adaptation which has been independently developed by farmers or farmer communities (autonomous adaptation) is an important basic capital (ADB, 2009). The implication, increasing adaptive capacity through planned adaptation that the development is conducted by the government or at least should be resting synergistically with autonomous adaptation that has been a tradition in the farmer community (Boer, 2007; Irianto, 2010).

Adaptation can be done in the form of land and water resource management in an optimal and sustainable, crop management and crop adapted to local climate conditions, the use of agricultural production infrastructure that effective and efficient, and the application of appropriate agricultural technologies that adaptive. Agricultural environmental management strategies can be done through a variety of planning efforts, adjustments, between agricultural practices, resource management and application of agricultural technologies to address climate change impacts and anomalies. The strategy adopted consists of short, medium and long term strategies, include:

1. Short-term strategies

a. Determine the crop calendar based on the valid data elements of climate and longer data series.

b. The selection of superior plant varieties tolerant to drought exposure, and short-lived as the anticipation of El-Nino phenomenon.

c. Monitoring of pests and diseases that commonly occur when a long rainfall season and the change of seasons.

d. Development and empowerment of institutional farmers, such as the integration of climate field school to the integrated crop management field schools and integrated pest control field school.

2. Medium-term strategy

a. Continuous monitoring of the phenomenon of climate elements change, especially rainfall, air temperature and humidity.

b. Repair and maintenance of facility and folder infrastructure and irrigation that already exist.

c. Application of soil and water conservation techniques, such as check dams, and ponds in drought-prone areas.

d. Establishment of institutional managers and water users

e. Empowerment of farmers through coaching and mentoring to confront climate change and climate anomalies of the agricultural business.

3. Long-term strategy

a. Development planning of the agricultural sector is more integrated, systematic and comprehensive by considering the various aspects related with the performance of the agricultural sector, especially the agroclimatology aspect.

b. Making rice roadmap in swampland in the era of climate change

c. Involvement the participatively community in every planning of agricultural development.

d. The pattern of good coordination among government agencies, especially those directly related to the agricultural sector through the synchronization and harmonization work program.

e. Monitoring area that often affected due to the climate change and anomaly periodic and continuous.

f. Dissemination of weather and climate information quickly, accurately and actually.

In addition to above, the strategy of economic development in the agricultural sector can be done by agribusiness approach. Agricultural development through agribusiness approach is a step in the right and proper because this approach vertically integrates upstream and downstream activities and horizontally various sectors so as to create a reasonable profit for the farmer. Agribusiness institutions that need to be developed is a group of farmers, farmers' water user associations, cooperatives and rural financial institutions, production facilities and infrastructure providers, marketing, and tool and machine of agriculture services. In addition to these two institutions, the empowerment of field extension also needs to be done because they are dealing directly with farmers. Empowerment of farmer organization aims to increase farmer participation in institutional farm. Community institutions such as the traditional institution is participate to moves the communities in together activities, grow and enhance the community's role in the activities initiated by the local government, as well as increasing self-reliance of farmers on agricultural development. Meanwhile, village unit cooperatives play to help the farmer members in obtaining credit, production fasility, and agricultural tools and accommodating and market outcomes.

CONCLUSIONS

Extreme climate change such as heavy rainfall in the rice farming in swampland either tidal swampland and non tidal swampland has negative impact on production. based on the value of the coefficient of variance (CV) behavior of farmers in the face of risk in two different seasons worth 0.45 to 0.48. This suggests that farmers of rice farming in tidal area have neutral risk behavior. CV value is relatively closer to the CV value when farmers face high rainfall and also relatively similar to the normal situation. If there is a risk or possibility of recurrence risk towards rice farming the decision maker (farmer) still does not reduce or enlarge their Adaptation strategies adopted by farmers in swampland consist of short, medium and long term strategies. Short-term strategies include: (a) Timing of planting (crop calendar) based on information of valid climate data that and based on the experience of the farmers themselves, (b) Selection of superior plant varieties tolerant to drought exposure, and short-lived as the anticipation of El Nino phenomenon; (c) Monitoring of pests and diseases that commonly occur when the long rains season and the change of seasons. (d) Institutional development and empowerment of farmers, such as climate field school integration to the integrated crop management field schools and integrated pest management field school.

RECOMMENDATIONS

Anticipation of climate change should referrals from various aspects, such as climate change adaptation, diversification of food production, social and cultural development of society, economy and institutional strengthening of farmers, and policies in favor of agriculture. In non tidal swampland, adaptation of climate change on farm level should be followed by the availability of input factors of production earlier. Seed subsidy policy strongly supports the adaptive capacity of the economy. In the tidal area, in addition to the availability of production factors as time of planting; also beyond the ability to substitute the non-family hired labor with family labor will be able to reduce the decline of income. Supporting factor such as role of breeding and seed certification center is to produce the seed that is capable of adapting to climate anomalies. Similarly, the provision of business credit to be able to support farmers businesses and it also must calculate the change adaptation of planting time. There must be the weather information that can be accessed by farmers' groups and an increase in the ability of extension worker in the field to be able to help farmers in the group level to adapt the climate change. In this era of climate change; diversification activities in swampland on-farm level (non-rice farming) need more attention. Fisheries and poultry activities especially ducks have great opportunities in an effort to increase household income and household economic strengthening of farmers from non-rice farming.

Income factor of non-farm level has a role in strengthening of household economic of rice farming affected by climate change. Therefore, the maximization of income from non-farm activities can be done through increasing skills and employment opportunities. Adaptive capacity of farmers in swampland should be based on strengthening the synergies between adaptation that has historically been developed independently by farmers with the planned adaptation introduced by the government.

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