

The potential of local government support for climate change adaptation of lowland rice farming

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Abstract. Climate change has impacted the production and productivity of agricultural commodities, including rice as the main food crop. All parties must play an active role in overcoming climate change impact, coming under the local government. This study was carried out by performing focus group discussions (FGD) and filling out questionnaires to identify the potential, opportunities, and problems faced in supporting climate change adaptation. A SWOT analysis was employed by considering Strengths, Weaknesses, Opportunities, and Threats. The study was conducted in two regencies in Central Java Indonesia, namely Purworejo and Banjarnegara, where a climate change adaptation program has been initiated. Local government support is needed to get continuity of climate change adaptation. The results show that the potential of local government support for climate change adaptation should prioritize the Strength Opportunity (SO) strategy. The choice of SO strategy is based on various strengths owned by the local government and many opportunities which can still be reached by growing people's awareness of climate change. The alternatives of local government support are providing information and appropriate innovations for climate change adaptation. Public awareness and willingness are means for successful adaptation. Physical program supports, such as infrastructure, should be equipped with non-physical programs and local regulations as reinforcement.

1 Introduction

The global warming has a negative effect on several life aspects. El Nino and La Nina phenomena are results of the current climate change. Climate change does not only cause global warming and rising sea levels but also threatens food security because it can have a negative impact on the agricultural sector, especially crop failure.

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The agricultural sector is a sector that is vulnerable to climate change [1][2][3]. Crop failure occurs due to prolonged droughts and floods that damage food crops. Some impacts which are likely to occur in the farming community due to global warming include a rising in plant pests and diseases, a rise in humidity, damage to agricultural land resources due to erosion, then crop failure, which can threaten food security [4][5]. Indonesia is one of the countries that has a high risk of being affected by climate change [6]. As an agrarian country, the agricultural sector not only contributes to meeting food needs but also takes part a major contribution in the formation of the gross domestic product (GDP) and a provision of employment [7][2].

As a main staple food in Indonesia, rice is one of the food crops that are vulnerably threatened by the changing in weather. Some implications of climate crisis on rice are decreased productivity and index crops, increased pest attacks, decrease in yield quality, and reduced paddy field area [8].

Efforts need to be made to maintain the performance of the agricultural sector in the midst of climate change. Currently, the Indonesian government has implemented various policies in marking negative effects of global warming on the agricultural sector [9], such as implementing the concepts of climate-smart agriculture, organic farming, sustainable agriculture and others [10]. The programs included in the climate change adaptation program, however, will not continuously be carried out by government. The widely of implications of climate crisis in all commodities, limitation fund, and most important is the expected contribution from many parties for example farmers, private company, and local government in local areas.

Given the prolonged of climate change effects, all parties must play an active role in overcoming its impacts, including farmers and government both central and local government. Reasons for the need for farmers to be actively involved in climate change adaptation. First, farmers are the ones directly affected by climate change. Second, farmers are the ones who contribute to the increase in greenhouse gas emissions.

Local governments also need an active role that deals directly with farmers in their area, especially in areas that are sensitive to the implications of climate crisis. The active role of local governments is related to the influence of global warming on crop production which will ultimately have a good effect on the regional economy in general. However, not all parties including local government are ready and prepared for the climate change adaptation and mitigation. The readiness can be shown from the local planning programs which includes the item of adaptation climate change on the list. Right after the central government finish the programs, other parties such as the local government is expected to give more contribution on climate change adaptation. Therefore, the objective of the research is to assess the potency of local government support to climate change adaptation especially in rice commodity to support food security in Indonesia.

2 Methodology

2.1 Time and Research site

The research was conducted in Banjarnegara and Purworejo Regencies, Central Java Province, Indonesia from October to December 2022. These two regencies were selected purposively according to the location of the Smart Climate Agriculture (CSA) as the primary initiative of global warming adaptation by Indonesian Central Government especially Ministry of Agriculture. Rice commodity was chosen based on consideration that rice is the main staple food in Indonesia and closely related to food security.

2.2 Data and data collection

Research data was in the form of primary data through survey and FGD, also secondary data which is taken from related parties such as study desks. The basic data namely strength, weakness, opportunity, and threat of local government support to climate change adaptation. Secondary data includes regional maps, production, and productivity of lowland rice in Central Java Province, agroecosystems, rainfall, flood, and drought events in Central Java.

Data collection techniques for SWOT analysis were obtained from observation and interviews with a list of questions. To make SWOT analysis steps and formulate recommendations, data collection were carried out using questionnaires in the form of a Google-form and conducting FGDs with stakeholders which were then formed for each SWOT variable using a modified model used by Ebonzo and Liu [11][12].

2.3 Data analysis

First, determining internal and external factors.

Second, developing those factors into strategies matrix.

Third, building factors in the strategies diagram (Figure 1).

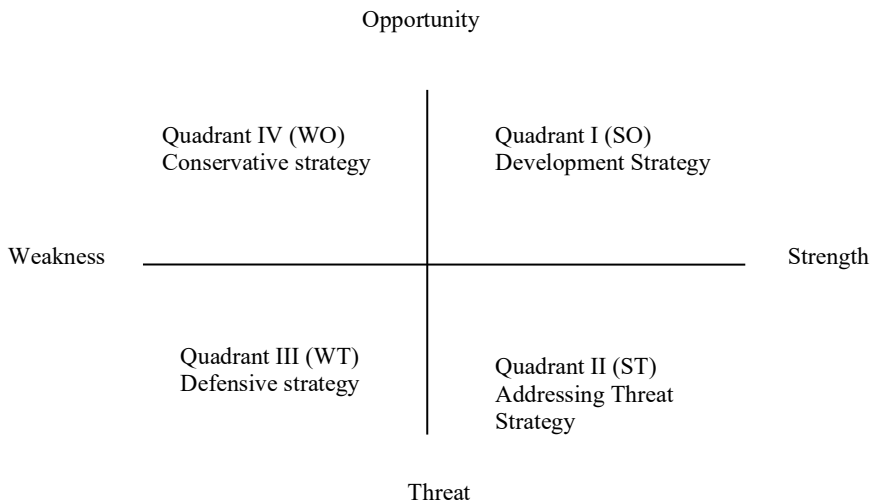


Fig.1. Internal and external factors strategies diagram

Fourth, arranging four-step strategy as follows:

- 1) The SO (Strengths-Opportunities) approach, a method utilized by agencies by exploiting or improving their strengths to make benefit of diverse possibilities.
- 2) The WO (Weaknesses-Opportunities) method is a technique that is utilized as effectively as appropriate to reduce current vulnerabilities to make benefit of diverse chances.
- 3) The ST (Strengths-Threats) strategy, a technique utilized by agencies by exploiting or optimizing strengths to mitigate certain dangers.
- 4) The WT (Weaknesses-Threats) technique, a technique utilized to diminish vulnerabilities in attempt to reduce or eliminate dangers.

3 Result and Discussion

3.1 Determining internal and external factors

Factors on the potential for local government support for climate change adaptation are determined. Table 1 lists ten internal factors which influence the potential of local government support for climate change adaptation, consisting of five strength factors and five weakness factors.

Table1. Strengths and weaknesses factors affect internal conditions.

Strengths	Weaknesses
1. Farmers' level of awareness of climate change is relatively high	1. There are no local government regulations governing climate change adaptation
2. Adaptation strategies have been implemented by some farmers, which can serve as examples for other farmers	2. Climate change adaptation, particularly in food crop commodities, has not yet become a priority scale in the regions.
3. Potential of natural resources such as land, organic matter, and water	3. The direction of development policy in the regions is very dynamic based on political directions
4. Human resources which have been trained, such as field officers	4. Some of the global warming response technologies still need to be improved and enhanced so they can be applied by farmers
5. Integration of central and regional government programs that support climate change adaptation	5. There are factors determining the application of technology that must be managed

Table 2 collects ten external environmental factors considered influential, consisting of five opportunity factors and five threat factors.

Table 2. Opportunity and threat factors affecting external conditions.

Opportunities	Threats
1. Climate issue where Indonesia must participate in a carbon emission reduction program	1. Global warming is predicted to continue in the coming years
2. Availability of proven technology innovations for climate change adaptation	2. The repercussions of global warming in the form of pest and disease attacks reduce agricultural yields
3. Initiation of climate change adaptation programs by the central government	3. Geographical conditions that are prone to disasters, such as landslides in Banjarnegara Regency
4. Supporting programs such as the development of agricultural infrastructure such as a more modern irrigation network	4. Farmers switch to other commodities or off-farm and non-farm activities
5. Designing dynamic short and long-term regional development directions	5. Young workers are no longer interested in the agricultural sector, especially lowland rice farming

3.2 Internal factor analysis strategy (IFAS) and external factor analysis strategy (EFAS) of climate change adaptation

After the internal and external factors are arranged, the SWOT analysis is carried out on the selected factors. SWOT analysis is carried out through a series of calculations known as internal factor analysis strategy (IFAS), external factor analysis strategy (EFAS), and

strategic factor analysis strategy (SFAS) calculations, taking into account weights and ratings. Table 3 shown the internal factors analysis strategy which contain its weight, rating, and score.

The integration of central and regional government programs that support climate change adaptation become the most affecting factor which mean the importance of local government's initiative and participation on programs. Furthermore, there is a need to manage the weaknesses to minimize the effects such the unapplicable technology to farmers, and informally regulation which has a chance to not be allowed. The formal regulation will support the field officer to legitimate the recommendations [13][14]. However, the regulation in the local/regional area is complicated thus not every district already including the climate change to the regulation (*PERDA*)[15]. The basic requirement it is should be in line with the vision and mission which is appointed by the gent.

Table 3. Internal factor analysis strategy.

Internal strategic factors	Weight	Rating	Score
Strengths			
1. Farmers' level of awareness of climate change is relatively high	0.091	8	0.728
2. Adaptation strategies have been implemented by some farmers, which can serve as examples for other farmers	0.114	8	0.912
3. Potential of natural resources such as land, organic matter, and water	0.092	7	0.644
4. Human resources which have been trained, such as field officers	0.093	7	0.651
5. Integration of central and regional government programs that support climate change adaptation	0.122	9	1.098
Subtotal			4.033
Weaknesses			
1. There are no local government regulations governing climate change adaptation	0.112	3	0.336
2. Climate change adaptation, particularly in food crop commodities, has not yet become a priority scale in the regions	0.081	4	0.324
3. The direction of development policy in the regions is very dynamic based on political directions	0.121	2	0.242
4. Some of the global warming responses technologies still need to get improved and enhanced so they can be applied by farmers	0.092	3	0.276
6. There are factors determining the application of technology that must be managed	0.082	4	0.328
Subtotal			1.506
Total			5.539

3.3 IFAS-EFAS diagram

Figure 2 illustrates the IFAS-EFAS diagram based on the total scores of IFAS and EFAS in Table 3 and Table 4. Based on the results of this analysis, the quadrant which is the meeting point of the IFAS and EFAS calculations is Quadrant I.

Quadrant I is a pretty advantageous scenario. The government has potential and advantages to ensure it is able to benefit of current prospects. The method that needs to be adopted in this scenario is to encourage the growth of forceful government initiatives (growth-oriented approach).

Table 4. External factor analysis strategy

External strategic factors	Weight	Rating	Score
Opportunities			
1. Climate crisis issue where Indonesia must participate in a carbon emission reduction program	0.094	7	0.658
2. Availability of proven technology innovations for climate change adaptation	0.098	8	0.784
3. Initiation of climate change adaptation programs by the central government	0.093	7	0.651
4. Supporting programs such as the development of agricultural infrastructure such as a more modern irrigation network	0.108	9	0.972
5. Designing dynamic short and long-term regional development directions	0.119	8	0.952
Subtotal			4.017
Threats			
1. Climate change is expected to continue in the coming years	0.111	3	0.333
2. The repercussions of global warming to the form of pest and disease attacks reduce agricultural yields	0.087	2	0.174
3. Geographical conditions that are prone to disasters, such as landslides in Banjarnegara Regency	0.118	2	0.236
4. Farmers switch to other commodities or off-farm and non-farm activities	0.089	3	0.267
5. Young workers are no longer interested in the agricultural sector, especially lowland rice farming	0.083	3	0.249
Subtotal			1.259
Total			5.276

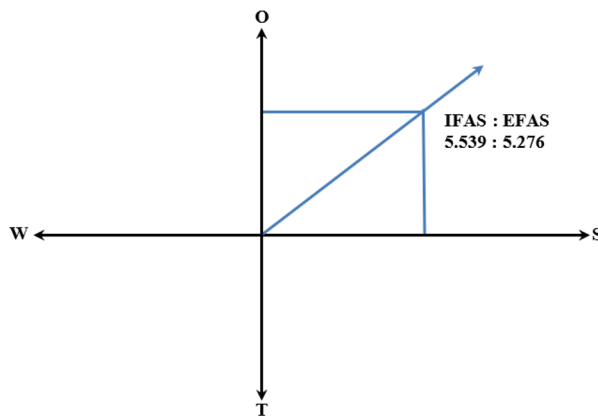


Fig. 2. IFAS-EFAS diagram

3.4 Strategy and recommendations for strengthening climate change adaptation

After knowing the position in which quadrant, the next step is to formulate a strategy for EFAS developing adaptation to the impacts of climate change. The strategies according to the SWOT analysis are as Table 5.

Table 5. Interaction matrix of IFAS-EFAS

IFAS EFAS	<p>Strengths (S)</p> <ol style="list-style-type: none"> 1. Farmers' level of awareness of climate change is relatively high 2. Adaptation strategies have been implemented by some farmers, which can serve as examples for other farmers 3. Potential of natural resources such as land, organic matter, and water 4. Human resources which have been trained, such as field officers 5. Integration of central and regional government programs that support climate change adaptation 	<p>Weaknesses (W)</p> <ol style="list-style-type: none"> 1. There are no local government regulations governing climate change adaptation 2. Climate change, particularly in food crop commodities, has not yet become a priority scale in the regions 3. The direction of development policy in the regions is very dynamic based on political directions 4. Some of the global warming modification technologies still need to get improved and enhanced so they can be applied by farmers 5. There are factors determining the application of technology that must be managed
<p>Opportunities (O)</p> <ol style="list-style-type: none"> 1. Climate issues where Indonesia must participate in a carbon emission reduction program 2. Availability of proven technology innovations for climate change adaptation 3. Initiation of climate change adaptation programs by the central government 4. Supporting programs such as the development of agricultural infrastructure such as a more modern irrigation network 5. Designing dynamic short and long-term regional development directions 	<p>SO strategy</p> <ul style="list-style-type: none"> ○ Technological innovations that have been tested are carried out by farmers with a high level of vigilance and are supported by modern irrigation infrastructure. ○ Utilizing the potential of natural resources by trained human resources such as field officers ○ Scaling up the central and regional government integration program to participate in climate change adaptation and mitigation 	<p>WO strategy</p> <ul style="list-style-type: none"> ○ The issue of global warming needs to be implemented in more binding regulations by increasing the role of local governments to make it happen by making it one of the directions of development in the region ○ Evaluate technological innovations that are appropriate and need to be improved by cooperating with relevant agencies ○ Dissemination of optimally tested technological innovations by prioritizing the determinants of adoption

Threats (T)	ST strategy	WT strategy
<ol style="list-style-type: none"> 1. Global warming is projected to continue in the coming years 2. The repercussions of global warming in the form of pest and disease attacks reduce agricultural yields 3. Geographical conditions that are prone to disasters, such as landslides in Banjarnegara Regency 4. Farmers switch to other commodities or off-farm and non-farm activities 5. Young workers are no longer interested in the agricultural sector, especially lowland rice farming 	<ul style="list-style-type: none"> ○ Increasing farmers' awareness of the consequences of global warming, which is predicted to continue to occur, by choosing the right adaptation strategy ○ Overcoming pests and diseases attacks by optimizing the role of farmers and trained officers ○ Agricultural mechanization to overcome labor shortages, especially among young people, with integrated roles and support from local and central government 	<ul style="list-style-type: none"> ○ With climate change still going on, it is a consideration for local governments to include adaptation programs as one of the contents of short-term development policies ○ Considering the reduced yields and farmers' income as the consequence of global warming, it is required to develop and adjust technology and optimize the management of technology application factors

Experience the lesson from two regencies, general strategies to enlarge the potential support of local government for climate change adaptation: (1) improving farmer understanding of global warming; (2) creating and building technology innovation which are relevant and inexpensive (3) Assessing and detecting potential hazards and weaknesses in the setting of socioeconomic and based on location challenges; [16] (4) assistance by local government including enforcement, educational substance, scaling up application of innovations.

4 Conclusion

Based on the existing strategies and the quadrant positions of the problems discussed in this study, the most suitable recommendation for climate change adaptation in both regency is the SO strategy. The SO strategy is very supportive of being implemented because of the various strengths that the local government has and sees opportunities that the government can still reach to grow people's awareness of the impacts of climate change and adapt to these impacts. The main strength that should be capital for the government is providing knowledge about the impact of climate change on farmers and motivation to apply the most appropriate technological innovations. The government can use public awareness and willingness as a means to make climate change adaptation programs successful. Physical program support is needed, such as infrastructure equipped with non-physical, i.e., institutions and technological innovations, and several local regulations as reinforcement.

References

1. A. I. Monterroso-Rivas, A. C. Conde-Álvarez, J. L. Pérez-Damian, J. López-Blanco, M. Gaytan-Dimas, and J. D. Gómez-Díaz, *Clim. Change* **147**, 457 (2018)
2. G. C. Nelson, H. Valin, R. D. Sands, P. Havlík, H. Ahammad, D. Deryng, and J.

- Elliott, PNAS **111**, 3274 (2014)
3. K. Thomas, R. D. Hardy, H. Lazrus, M. Mendez, B. Orlove, I. Rivera-Collazo, J. T. Roberts, M. Rockman, B. P. Warner, and R. Winthrop, *Wiley Interdiscip. Rev. Clim. Chang.* **10**, 1 (2019)
 4. N. A. Khan, U. Khanal, C. Wilson, A. A. Shah, and M. A. U. R. Tariq, *Sustain.* **14**, (2022)
 5. L. Pereira, *Climate Change Impacts on Agriculture across Africa* (2017)
 6. K. Kurniawan, J. Supriatna, J. Sapoheluwakan, T. E. B. Soesilo, S. Mariati, G. Gunarso, and Fatimah, *AgBioForum* **24**, 1 (2022)
 7. S. A. Fazal, T. Chittagong, and S. A. Wahab, *J. Transform. Entrep.* **1**, 39 (2015)
 8. S. Sujariya, N. Jongrunklang, B. Jongdee, T. Inthavong, C. Budhaboon, and S. Fukai, *Plant Prod. Sci.* **23**, 48 (2020)
 9. M. Rondhi, A. F. Khasan, Y. Mori, and T. Kondo, *Land* **8**, (2019)
 10. R. D. Lasco, C. Ne, M. D. Habito, R. Jane, P. Delfi, F. B. Pulhin, and R. N. Concepcion, *Climate Change Climate Change Adaptation for Adaptation for Smallholder Smallholder Farmers in Farmers in Southeast Asia Southeast Asia* (2011)
 11. A. D. Menga Ebonzo and X. Liu, *Qual. Quant.* **47**, 2671 (2013)
 12. L. Hutahaean, E. Sirnawati, E. S. Rohaeni, and B. Bakrie, in *3rd Int. Conf. Agribus. Rural Dev. (IConARD 2022)* (2022), p. 15
 13. D. Etongo and K. Gill, *Challenges* **13**, 49 (2022)
 14. C. of the B. S. S. (CBSS), (2019)
 15. L. Y. Sulistiawati, *IOP Conf. Ser. Earth Environ. Sci.* **423**, (2020)
 16. N. Brooks, W. N. Adger, and P. M. Kelly, *Glob. Environ. Chang.* **15**, 151 (2005)