The implication of climate adaptation and mitigation research: capacity adaptation of rice paddy farmers to climate change

Idawati1,2, Hubeis3, Fatchiya3, Asngari3 and Tjitropranoto3

1Department of Agribusiness, University of Andi Djemma, Palopo, South Sulawesi
2Doctoral Extension Education Development Program, Graduate School, Bogor Agricultural University, Campus IPB Dramaga, 16680, Indonesia
3Communications Science and Community Development Departement, Faculty of Human Ecology Bogor Agricultural University, Campus IPB Dramaga, 16680, Indonesia

Corresponding author: idawati_ida@apps.ipb.ac.id

Abstract. Climate change requires adjustment, resilience, anticipation, coping with stress or changes to sustainable agricultural development in socioeconomic and biophysical systems. Climate change affects the plants, livestock and also the environment, thus a reactive adaptation by paddy farmers is necessary. A purposive sampling on 30 respondents who had accomplished the Climate field school (CFS) program in “Mandiri” and group of women farmers “ Dalima”. The study was conducted from October to November 2017 in Situ Gede sub-district, Bogor, Indonesia. This study used the descriptive analysis with frequency distribution table to describe the respondent distribution of each variable. The research objective is to describe the ability of farmers to adapt to climate change and to realize the sustainability of rice farming. The results obtained are the application of adaptation ability of paddy farmers to changes in rainfall patterns in the form of technical capabilities (knowledge), institutions, social capital, access to business capital is categorized medium, while the technical ability of adaptation (action) is high. Furthermore, the ability of farmers to adapt to the sustainability of socio-cultural lowland rice farming is high in assessing persistence and togetherness are important factors in farming success. The implication is that the technical adaptability of rice farmers will be high if the socio-cultural values and cooperation of rice farmers are maintained as in planning the timing of planting, harvesting and marketing.

1. Introduction

Various climate stimuli, including rising temperatures, changes in variability in rainfall and sea and extreme climates (floods and droughts), have a variety of negative impacts in rural areas, such as reducing agricultural production and employment [1]. This impact requires efforts to increase adaptive capacity through changes in knowledge, attitudes and skills of farmers through a gradual approach to adaptive capacity assessment will have a better effect on change. Changes to factors that influence adaptation capacity include socio-economic factors, technology, infrastructure, and government policies to achieve sustainable development [2].

The level of knowledge of farmers in the area of climate research without them realizing is reflected in the progress and sustainability of their farming so far. Knowledge of climate change, especially
rainfall patterns, allows farmers to make adjustments to these changes. It can be seen in the study area in Situ Gede Village, West Bogor District, Bogor Regency which is an area with high rainfall intensity. Paddy rice farmers in the region try to manage water according to the needs and types of rice varieties to be planted. The farmers are food crop farmers who have experienced applying several ways of adaptation when all possible changes in rainfall patterns occur.

The ability of farmers to adapt is not only obtained through information on climate field school more moreover also by their own efforts with other farmers’ friends [3]. Adaptation ability measured through the tried experience with the sustainability of farming on the same commodity continuously. The ability of farmers is the adaptation capacity of farmers in determining and implementing actions that must be taken to increase crop production in high or low rainfall conditions.

In connection with the description above, the purpose of the study is to describe the adaptation ability of paddy farmers to changes in rainfall patterns and in realizing sustainable farming.

2. Research methods
This study uses a quantitative approach in descriptive analysis supported by data and qualitative analysis. The data was collected from the questionnaire guide that gave to a number respondent.

A purposive sampling on 30 respondents who had accomplished the Climate field school (CFS) program in “Mandiri” and group of women farmers “Dalima”. The study was conducted from October to November 2017 in Situ Gede sub-district, Bogor, Indonesia.

3. Results and discussion

3.1. Adaptation ability of paddy rice farmers
Adaptation ability of paddy rice farmers in this study consists of technical, institutional, social cultural capabilities and access to farming capital. These adaptation capabilities are mutually influential and can overcome the problem of climate change, especially rainfall which has an impact on the food crop sector.

3.2. Technical ability
Farmers as rice cultivators receive the biggest negative impacts due to climate. Cultivation habits that are carried out both from cropping patterns, maintenance of plants that rely on habits are very vulnerable and at risk of being affected by extreme climate events. Technical ability starts from the existence of information both from the individual experience gained during managing the farm and from the external.

Table 1 below explains that most of the farmers have made adaptation actions, it can be seen by the farmers’ ability to take action from the results of previous adaptation knowledge and experience. Technical ability to change knowledge from research results obtained is medium. Farmers are able to understand the benefits of immersing rice straw after harvesting into the field (gelebek) which functions as fertilizer in the soil. Farmers understand the replacement of inundated or drought resistant rice varieties following seasonal changes, can irrigate rice continuously according to varieties by understanding the benefits of intermittent irrigation to improve crop roots and save the water. It is supported by Las et al. (2006) [4] that stated knowledge of farmers in the food crop sub-sector is very important because food crops are most vulnerable to changes in rainfall patterns. Food crops are generally seasonal crops that are relatively sensitive to stress (excess and lack) of water. Technically, the vulnerability of food crops is closely related to land use systems and soil properties, cropping patterns, soil management technology, water, and types of plant varieties.

In Table 1, it can be seen that the technical ability in adaptation/action of farmers in the high category is that farmers are able to choose superior seed varieties of rice that are resistant to pests. Farmers have followed the planting schedule by using the planting calendar (Katam) together with other farmers, using organic compost, using Inpara 4 and 5 varieties that are soaked and inundated. It reinforced by government recommendations regarding the introduction of Sub1 genes which allow plants to survive in stagnant conditions for 10-14 days. These actions are in accordance with the general guidelines for the adaptation from the Ministry of Agriculture and FAO [5].
Table 1. Percentage of adaptation capability of paddy farmers

| No. | Internal factors of farmers                  | Category | Percentage (%) |
|-----|---------------------------------------------|----------|----------------|
| 1.  | Technical Skills (Knowledge)                | Low      | 13.3           |
|     |                                             | Medium   | 76.7           |
|     |                                             | High     | 10.0           |
| 2.  | Technical ability (adaptation/action)       | Low      | 20.0           |
|     |                                             | Medium   | 3.3            |
|     |                                             | High     | 76.7           |
| 3.  | Institutional Ability                       | Low      | 6.7            |
|     |                                             | Medium   | 86.7           |
|     |                                             | High     | 6.7            |
| 4.  | The ability of Social Capital               | Low      | 23.3           |
|     |                                             | Medium   | 40.0           |
|     |                                             | High     | 36.7           |
| 5.  | Capital Access Ability                      | Low      | 30.0           |
|     | Farming                                     | Medium   | 70.0           |
|     |                                             | High     | 0              |

Information n = 30 people

3.3. Institutional ability

The strengthening of farmer group institutions is almost entirely lacking. It is due to the activities of the farmers’ group as part of the respondents in partnering with the private sector. Group activities are less active in socializing institutions and most of it are still individual. Coordination and synchronization of climate change adaptation actions to build common perception, commitment and integration among sub-sectors in the agricultural sector, between sectors, and between the central and regional governments in implementing climate change adaptation activities have not run optimally.

The institutional capacity of farmers in adapting is strongly influenced by some factors such as, the capacity of self-efficacy, perception through farmer experience, and socio-economic factors. Besides that it is influenced by education, a number of family members, annual household income, access to information, credit, and membership of farmer-based organizations. The same thing according to Ndamani and Watanabe (2015) [6], that the main constraints of farmer adaptation are the inability to predict the weather, high input costs, lack of access to weather information and water resources that are always available and government institutional support.

3.4. The ability of social capital

The ability of social capital in the research results is in the medium category, most of them are indigenous people in the local area who have the same culture and habits. The diversity of society sometimes makes social capital fade where there are differences in rules and values that are considered sacred and affect citizens to take action. Social capital according to Elum et al. (2017)[7] affect increasing technical knowledge for farmers in adapting to climate change in Bangladesh. Human resource development in terms of technical capabilities will be more effective in solving problems if accompanied by a cultural approach. This approach for the community is very sensitive if it relates to customs and culture so that in adoption actions must understand the social, cultural and economic conditions of the target innovation.

Islam religion and Sundanese stated that the majority of farmers in the same area of research, have the same norms and values so togetherness is still intertwined. The cooperation in farm managing still exists, which can be assessed by the habit of helping each other in harvesting and drying of rice. The habits of farmers who still obedient to the values and principles of togetherness much influenced by the
motivation of needs and follow the requirements required in farming activities that owned from generation to generation. In contrast to modern urban areas outside the agricultural sector that pressed by needs and high levels of competition force citizens to be more individual.

Efforts to increase individual capacity include learning efforts both from the realm of knowledge, attitudes or critical awareness and skills. In the community development cycle, the capacity building process is carried out repeatedly and continuously so that awareness of development will become a culture and part of each individual in the community. In this case the role of convergent communication, and extension performance is very necessary, especially in the process of sharing information and knowledge for farmers and among stakeholders [8].

3.5. Ability of business capital

The farmers’ capital comes from their own and additional loan from bank. The ability to access farmers’ capital can provide motivation and opportunities to smooth business capital. The same thing according to Fatchiya (2010) [9] that the larger the farmers’ business capital loans will be directly proportional to the motivation and ability of farmers in managing their farms, because of the demands of loans to be paid and urgent family life needs. This can be seen in the location of the study that with the provision of inputs to the land processing process, the use of aid workers in planting, the purchase of fertilizers and pesticides can increase the role of farmers in managing their farming.

3.6. Sustainability of farming

The influence of climate change on the agricultural sector is multidimensional, ranging from resources, agricultural infrastructure, agricultural production systems, to aspects of food security and independence, as well as the welfare of farmers and society in general. The influence is divided into two indicators, namely vulnerability and impact. The impacts of climate change are "disturbances or conditions of losses and benefits, both physically and socio-economically caused by climate change stresses" [10].

In Table 2, it can be seen that the increase in production is broadly distinguished based on how the farm production changes before and after doing farming with climate change adaptation pattern. More than half of the respondents selected felt that the increase in production tended to increase when they followed the planting schedule together according to the planting calendar. According to farmers planting simultaneously following the specified planting season schedule will reduce the pest attack and, able to get water in turn. This is very important for the farmer respondents who complain that the availability of irrigation water is not optimal, due to the amount of garbage that covers the irrigation channel. The importance of irrigation water availability for lowland rice farmers so that it is necessary to consider changes in rainfall patterns that influence the expected water supply, which is expected to increase production and planning three times in 2 years.

Environmental sustainability in Table 2, for non-profit farmers the results are being available for irrigation water to irrigate rice fields. Irrigation water sources come from urban areas to the study area. Irrigation water is still relatively smooth in the study area because it is an area with high rainfall, but in terms of environmental pollution that occurs because the irrigation canals are filled with waste sourced from urban residential households. This needs to be carried out socialization activities to local government officials in order to be wiser in setting permits for the location of opening agricultural land in forest areas and areas that are not intended for agriculture in accordance with Law No. 23/1997 concerning the environment to prevent deforestation and degradation of forests and agricultural land.

The sustainability of farming in the socio-cultural dimension at the research location in Table 2 is very high, where the respondent farmers rate that the value of persistence and togetherness is an important factor in the success of rice farming farmers. Respondent farmers desperately need cooperation in terms of planning the timing of planting, processing to marketing. This indicator sometimes becomes a social obstacle (normative and perceptive/cognitive) and varies from one region to another. Social barriers that are based on values, goals, characteristics and cultural perspectives that are very specific, which is very dependent on work adaptation and conditions in the field.
Table 2. Percentage of business continuity in the application of paddy farmer adaptation capabilities

| No. | Internal factors of farmers | Category  | Percentage (%) |
|-----|-----------------------------|-----------|----------------|
| 1.  | Increased Production        | Low       | 13.3           |
|     |                             | Medium    | 66.7           |
|     |                             | High      | 20.0           |
| 2.  | Environmental Sustainability| Low       | 16.7           |
|     |                             | Medium    | 63.3           |
|     |                             | High      | 20.0           |
| 3.  | Socio-cultural Values       | Low       | 0              |
|     |                             | Medium    | 20.0           |
|     |                             | High      | 80.0           |

Information n = 30 people

4. Conclusions and suggestions

4.1. Conclusion
Application of adaptation ability of paddy farmers to changes in rainfall patterns in the form of technical capabilities (knowledge), institutions, social capital, access to business capital categorized medium while the technical ability of adaptation (action) is high. Furthermore, the ability of farmers to adapt to the sustainability of socio-cultural lowland rice farming is high in assessing persistence and togetherness are important factors in farming success. The implication is that the technical adaptability of rice farmers will be high if the socio-cultural values and cooperation of rice farmers are maintained as in planning the timing of planting, harvesting and marketing.

4.2. Suggestion
The diversity of adaptation abilities of lowland rice farmers in the sustainability of farming that can be explained by the results of the research obtained is still very small. So it requires significant variable addition which is an influencing factor that has not been measured by the researcher, besides the limited number of respondents so that the representation of the rice farmers’ population is not optimal and needs further research.

Reference
[1] Gallopin G C 2006 Linkages Between Vulnerability, Resiliensi, and Adaptive Capacity Journal Global Environmental Change 16 293 -303
IPPC 2013 Climate Change 2013: The Physical Science Basis Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (USA: Cambridge University Press)
[2] Zheng Y and Dallimer M 2016 What Motivates Rural Households To Adapt To Climate Change Climate and Development Journal 8 110-21
[3] Tjitropranoto P 2003 Agricultural Counseling: Present and Future Forming Patterns of Human Behavior Development: Dedicated to Prof. Dr. H.R. Margono Slamet ed I Yustina and A Sudradjat (Bogor: IPB Press)
[4] Las I, Subagyono K and Setiyanto A P 2006 Environmental issues and management in revitalizing agriculture Agricultural Research and Development Journal 25 106-14
[5] Ministry of Agriculture 2011 Adaptation to Climate Change Agriculture Sector, General Guidelines for Agricultural Research and Development Agency (Jakarta: Ministry of Agriculture)
FAO 2014 Adapting to climate change through land and water management in Eastern Africa Results of pilot projects in Ethiopia, Kenya and Tanzania (Rome: FAO)
[6] Ndamani F and Watanabe T 2015 Determinants of Farmers’ Adaptation To Climate Change: A Micro Level Analysis in Ghana *Scientia Agricola Journal* **73** 201-08

[7] Elum Z A, Modise D M and Ana M 2017 Farmer’s Perception Of Climate Change And Responsive Strategies In Three Selected Provinces of South Africa *Risk Climate Management* **16** 246-57

[8] Idawati 2016 The Role of Agricultural Extension Agents in the Management of Cocoa Cultivation in the Pengkendekan Village, Sabbang District, North Luwu Regency *Journal of Sustainable Agriculture* **4** 1-21

Oktavia Y, Muldjono P, Amanah S and Hubeis M 2017 Relationship between Communication Behavior and Capacity Building for Freshwater Fisheries Agribusiness Actors in Padang, West Sumatra *Extension Journal* **13** 157-65

[9] Fatchiya A 2010 Level of Capacity of Fish Cultivators in Managing Sustainable Aquaculture *Businesses Extension Journal* **6** 74-83

[10] Sanchis-Ibor C, Boelens R and Garcia-Molla M 2017 Collective Irrigation Reloaded: Re-Collection And Re-Moralization Of Water Management After Privatization in Spain *Journal Geoforum* **87** 38–47