Rice farmers’ adaptation practices to climate change: a case of Konda subdistrict in Southeast Sulawesi

H Saediman¹, M A Limi¹, Y Indarsyih¹, S Abdullah² and W O Yusria³

¹Department of Agribusiness, Halu Oleo University, Kampus Hijau Anduonohu, Kendari 93232 Sulawesi Tenggara, Indonesia
²Department of Agricultural Extension, Halu Oleo University, Kampus Hijau Anduonohu, Kendari 93232 Sulawesi Tenggara, Indonesia
Correspondence: saediman@yahoo.com

Abstract. Climate change can have an adverse impact on rice farming, so farmers might have to apply adaptation practices to address the impact. This research aimed to determine rice farmers’ adaptation practices in response to their perceived changes in climate. The study was conducted in Cialam Jaya Village, Konda Sub-district, South Konawe District, Southeast Sulawesi. Data were collected using questionnaire-based interviews and Focus Group Discussions. Respondents consisted of sixty-seven rice farmers who were selected using simple random sampling method. Descriptive statistics were used to analyze the data and information. Study results showed that most of the farmers had implemented adaptation practices as a response to climate change. Farmers have implemented adaptation methods in planting date, rice planting, improved seed varieties, fertilizer application, water management, crop diversification, livestock raising, and off-farm activities. The study recommended that suitable adaptation strategies need to be identified and the new ones need to be developed, and farmers should be assisted in their implementation to improve rice farming’s productivity and competitiveness.

1. Introduction
Climate change has presented a serious challenge to agriculture, including low-land rice as a water-intensive crop. Climatic factors, namely, solar radiation, rainfall, and temperature, are essential determinants of rice growth and development, so the variability of those factors directly affects rice production [1]. Climate change can also indirectly affect rice production through water shortage, changing soil moisture content, flooding, and pest and disease outbreak [2]. Besides, extreme weather events such as torrential rains and drought due to climate variability can be detrimental to crop and animal productivity [3].

Rice production plays a vital role in the Indonesian economy. Rice is the staple food for 97 percent of the population [4] and millions of farmers earn a living from it. As such, rice production contributes to income generation, poverty alleviation, and food security promotion. To attain these roles, the government has adopted various policies and programs to increase rice production. At the same time, given the possible adverse effect of climate change, the government, farmers and stakeholders need to take adaptation measures to address its impact.

In Southeast Sulawesi, rice is the main staple food [5] and is grown mostly in low-land areas. Cialam Jaya village is one of the major rice production areas in South Konawe Regency of Southeast Sulawesi. The village came into being with the arrival of the state-sponsored migrants from Ciamis of West Java and Lamongan of East Java in 1973 and it has been famous as a rice production area [6]. Previous study
suggests that many farmers perceived erratic rainfall, increased temperature, and more frequent extreme weather events. A large percentage of farmers also perceived the climate change impact on rice farming, such as changes in planting date, flooding, difficulty with harvesting, pest and disease outbreak, and more frequent droughts [6]. Based on these perceptions, farmers may have adopted adaptation strategies to maintain food production systems in the area.

In the face of climate change, it is crucial to understand the existing adaptation measures that farmers have been practicing in their rice fields. Studies on the local adaptation measures to address climate change impact have been very minimal in Southeast Sulawesi. This paper aimed to determine local adaptation measures that rice farmers have adopted so far as part of their livelihood strategies. Information on such local adaptation measures is useful to provide recommendations to help improve the current rice production systems to be more efficient and adaptable to future climate variability.

2. Methodology
The present study was a follow-up of a previous study in the same village regarding rice farmers’ perception of climate variability [6]. Data collection was carried out in Cialam Jaya village, Konda sub-regency, South Konawe regency. Respondents consisted of 67 rice farmers who were selected using a simple random sampling method. Data were collected using questionnaire-based interviews and Focus Group Discussions (FGDs). The questionnaire-based interviews were carried out in May 2019 to June 2019, while FGDs were conducted in July 2020. Both interviews and FGDs were focused on the adaptation measures and general perception and rationales of each adaptation measure. Data were analyzed qualitatively using percentage and mean.

3. Results and discussion
Survey results showed that farmers applied several adaptation practices to cope with the effect of climate change. As Table 1 shows, the adaptation practices that farmers have adopted include changing planting date, simultaneous planting, the use of superior varieties, the use of organic fertilizer, the use of water pump, crop diversification, livestock raising, and off-farm jobs.

| No. | Adaptation measures                  | Percentage |
|-----|-------------------------------------|------------|
| 1   | Changing planting date              | 83.6%      |
| 2   | Practicing simultaneous planting    | 80.6%      |
| 3   | Planting superior varieties         | 58.2%      |
| 4   | Applying organic fertilizer         | 9.0%       |
| 5   | Using water pumps                   | 35.8%      |
| 6   | Practicing crop diversification    | 52.2%      |
| 7   | Raising livestock                   | 56.7%      |
| 8   | Finding off-farm jobs               | 41.8%      |

3.1. Changes in planting date
Table 1 shows that almost 83.6 percent of respondents changed the planting date, which is usually determined based on the rainfall and the average monthly precipitation. Based on the average monthly rainfall, the general rule for planting dates in the study area is in January for the first cropping season and June for the second cropping season. Planting in January is expected to anticipate the peak rainy season in May-June for harvest while planting in June can escape drought in September to November. However, the actual amount and distribution of rain fluctuate every year, so farmers adjust the planting date. For this reason, the planting date is often delayed until February for the first cropping season and in July for the second cropping season.
3.2. Simultaneous planting
One adaptation measure that farmers have been practicing for years is simultaneous planting. Simultaneous planting means that all farmers complete rice planting within a week. In reality, however, not all farmers applied it for several reasons. Being busy with other crops or doing non-farm work are often the mentioned reasons. At present, with increased challenges due to climate change, the need for simultaneous planting becomes stronger. The most significant advantage of simultaneous planting is reducing and spreading the risk of pest and disease occurrence. Other advantages include making input distribution and harvesting easier to do, improving efficiency in using agricultural tools and machinery, and facilitating irrigation management. As Table 1 shows, the number of farmers who participated in simultaneous planting was 80.6 percent. To make this more effective, village residents plan to adopt village regulation on simultaneous planting in 2020, which will require all farmers to observe simultaneous planting starting from the first cropping season in 2021.

3.3 Use of superior varieties
Table 1 shows that 58.2 percent of respondents planted improved seed varieties in planting season 1 and planting season 2. Varieties planted included Mekongga, Ciherang, and Inpari, which are known as superior varieties in terms of, among others, yield and tolerance to pest and disease. However, for planting season 2, farmers also grow Trisakti, which is perceived as shorter-maturing and consuming less water. Shorter-maturing varieties are suitable in planting season 2 to anticipate water shortages in the September to November period.

It is noteworthy that instead of purchasing and planting certified seeds, 41.8 percent of respondents used their seeds from the previous harvest. This result is in line with the finding of Utami et al [7] with farmers in Gunung Kidul, Yogyakarta. Farmers argued that rice plants from certified seeds often showed regular performance similar to that from their previous harvest. On the other hand, farmers perceived seeds from the previous harvest as cheap and suitable for the local environment. During FGDs in July 2020, farmers mentioned that farmers’ percentages using seeds from the previous harvest had reached approximately 75 percent. This result presents a challenge for the agricultural extension office to increase the use of superior varieties again.

3.4. Application of organic fertilizer
The use of organic fertilizer is the least adopted adaptation practice. Farmers acknowledged that organic fertilizer, which is usually from cattle manure, can improve soil fertility. However, farmers usually do not use it because it is bulky and difficult to be transported to the field and needs some costs. Therefore, farmers prefer inorganic fertilizer and apply organic fertilizer only after their rice fields are no longer fertile.

3.5. Use of water pumps
Despite being rainfed with high dependence on precipitation, rice fields in the study village receive ample rainfall. The land is generally wet with an annual rainfall of 2,158 mm and eight wet months during 2009-2018 [6]. Hence farmers generally have no problems with water availability in the first cropping season. Water scarcity occurs in the second cropping season, which usually starts in June or July since the months from August until November are dry months with average monthly precipitation less than 100 mm. Therefore, farmers whose rice fields are located away from water bodies usually use water pumps to move water to their crops.

As shown in Table 1, 35.8 percent of respondents were using water pumps to water their crops. The type of water pump used is the surface water pump, placed on the ground with a hose to suck water and then move it to the crops in the field. In the regular year, the use of water pumps and shorter-maturing varieties is generally sufficient to ensure a good harvest. This enables the planting index of 2.0. However, rice fields located near the water source generally do not require the use of water pumps. These plots are usually planted with short-duration crops such as water spinach (kangkung) and amaranthus (bayam) after the cropping season 2 ends in October-November.
3.6 Crop diversification
Table 1 reveals that 52.2 percent of respondents applied crop diversification, namely cultivating crops other than rice such as pepper, citrus, cocoa, and short duration crops. They usually grow these crops in their dryland plots obtained from the government when they came to the village as part of the transmigration program in 1973. Each household received 2 ha of land, including 0.5 ha of housing and 0.75 ha of dry land. Their land ownership, both low-land and upland, gradually increased as they bought land from native people.

Crop diversification allows farmers to have additional income, especially because the study village is close to Kendari, the provincial capital, which is a big market for any agricultural produce. Crop diversification enables farmers to reduce harvest failure risks since they could still rely on other crops if rice farming fails due to flooding, drought, or pest and disease. Therefore, despite their general perception of rice as a crop with high failure risks, farmers still maintain favorable rice farming opinion. They still think rice farming as their primary source of income, which should be maintained. For this reason, cases of farmers abandoning their low-land plots are negligible. This condition is different from those in several areas where farmers shift to other crops due to, among others, less net returns from rice farming compared to that of other crops [8].

3.7 Livestock raising
Livestock raising is widespread among respondents in the study area. In the past, cattle were generally raised as a source of power to perform agricultural operations. At present, when all farmers have used tractors in the preparation of land for rice cultivation, many farmers have still reared cattle. As indicated in Table 1, 56.7 percent of respondents rear cattle. This implies that livestock raising is suitable for the conditions and needs of farmers. There are several reasons for this result. First, cattle raising provides additional income and functions as saving and social security assurance [9]. Second, cattle raising is regarded as one of the farming units in addition to low-land and upland crops. Third, cattle raising is in line with rural villagers’ characteristics who mostly do not want to borrow money from banks. Fourth, farmers usually have relatively large house-yard and drylands. This land availability is crucial for cattle to graze under the traditional rearing method using either an extensive or tethering system. Livestock raising as an essential resource for coping with climate change has also been reported by Silvestry et al and Suantapura [10]. Other studies identify livestock raising as a factor that can affect the adaptation method [11].

3.8 Involvement in off-farm or non-farm jobs
To reduce the effect of climate change, farmers involve in off-farm jobs. As Table 1 shows, about 41.8 percent of respondents are involved in off-farm jobs. It means that while working with rice production, farmers are also involved in off-farm jobs. Men usually do off-farm work in Kendari and surrounding areas as paid workers in construction-related activities. Farmers involve in off-farm jobs after completing specific tasks in rice farming operations, and they are usually back to work in their rice field when they are required to do so. Another popular off-farm work, notably with women, is intermediaries for farm outputs either as collectors or retailers. As intermediaries, farmers collect farm outputs, especially vegetables, from their fellow farmers and sell them to markets in Kendari.

4. Conclusion
Rice farmers have adopted a number of adaptation practices to climate change. In order of frequency, the practices adopted are changes in planting date, simultaneous planting, use of superior varieties, livestock rearing, crop diversification, involvement in off-farm jobs, use of water pumps, and use of organic fertilizer. These adaptation measures are limited to simple practices given farmers’ lack of knowledge, skill, and resources. The local government and stakeholders need to identify suitable and effective adaptation strategies, adopt policies and programs that address barriers for their adoption, and assist farmers in improving rice farming productivity and competitiveness.
References

[1] Korres N E, Norsworthy J K, Burgos N R, Oosterhuis D M 2017 Temperature and drought impacts on rice production: An agronomic perspective regarding short- and long-term adaptation measures Water Resour. Rural Dev. 9 12–27.

[2] Lansigan F, de los Santos W, Coladilla J 2000 Agronomic impacts of climate variability on rice production in the central highlands of Vietnam Agric. Sci. Procedia. 5 83–88.

[3] Rosenzweig C, Iglesias A, Yang X B, Epstein P, Chivian E 2001 Climate change and extreme weather events; implications for food production, plant diseases, and pests Glob. Chang. Hum. Heal. 2 90–104.

[4] Saediman H, Limi M A, Rosmawaty, Arimbawa P, Indarsiyih Y 2016 Cassava consumption and food security status among cassava growing households in Southeast Sulawesi Pakistan J. Nutr. 15 1008–16.

[5] Tripathi A, Mishra A K 2017 Knowledge and passive adaptation to climate change: An example from Indian farmers Clim. Risk Manag. 16 195–207.

[6] Saediman H, Lasmin L O, Limi M A, Rianse U, Geo L 2020 Rice farmers’ perception of climate variability in South Konawe District of Southeast Sulawesi Int. J. Sci. Technol. Res. 9 3128–32.

[7] Utami M, Saediman H, Abdullah S, Daud L, Yunus L 2019 Determinants of household food expenditure in a cassava growing village in Southeast Sulawesi Acad. J. Interdiscip. Stud. 8 302–10.

BPS 2018 Perkembangan beberapa indikator utama sosial-ekonomi Indonesia November 2017 (Jakarta: BPS).

[8] Saediman H, Mustika, Nalefo L, Tufaila M, Zani M 2019 Cost and return analysis of rice farming and brick making in South Konawe District of Southeast Sulawesi Int. J. Sci. Technol. Res. 8 835–38.

[9] Surni S, Saediman H, Wulandari F, Zani M, Yunus L, Taridala S A A 2020 Profitability and constraints of small-scale tomato production in Baubau municipality of Southeast Sulawesi, WSEAS Trans. Environ. Dev. 16 219–225.

[10] Silvestri S, Bryan E, Ringler C, Herrero M, Okoba B 2012 Climate change perception and adaptation of agro-pastoral communities in Kenya Reg. Environ. Chang. 12 791–802.

[11] Deressa T T, Hassan R M, Ringler C, Alemu T, Yesuf M 2009 Determinants of farmers’ choice of adaptation methods to climate change in the Nile Basin of Ethiopia Glob. Environ. Chang. 19 248–55.