Farmers’ adaptation in dealing with limited water (A case study on Wonogiri Regency)

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Abstract. The vulnerability of farmers to drought is determined by the interaction of the potential impacts of climate change. The impact of climate change is felt by residents of Paranggupito District, one of which is in Ketos Village in the agricultural sector, especially rainfed land which is very vulnerable to long drought conditions. Farmers’ losses to drought are determined by the interaction of climate change impacts and farmers’ adaptation. This research aims to find out the adapting strategy the farmers take in dealing with water limitation. The subject of research consisted of farmers in Ketos Village, Paranggupito Sub District, Wonogiri Regency. The research design used was descriptive qualitative one with purposive and snowball sampling techniques. Data collection was carried out using observation, in-depth interview, focus group discussion, and documentation. Data was analyzed using triangulation technique. The result of research shows that to adapt to their condition, the farmers adopt short- and medium-term adapting behaviour, including: determining crop calendar, selecting plant variety, applying intercropping system, determining appropriate planting pattern, controlling pest and disease, determining planting technique, and monitoring continuously.

1. Introduction

Indonesian area has a strategic position, located in tropical region, between Asia and Australia continents, between Pacific and Indian Oceans, and passed through by equator, making it vulnerable to climate change. Climate is so closely related to weather change [1]. Weather changes and global warming can reduce farming production by 5-20 percents. BMKG’s (Meteorology Climatology and Geophysics Council) data [2] indicates that the phenomenon of weather variability can be observed from the change of average rainfall pattern in Indonesia. The highest agricultural production data on the contribution of Central Java’s GDP (Gross Domestic Product) in 2010-2014 was Wonogiri Regency at 35.01%, processed by BPS (Central Bureau of Statistic) of regency [3] in the period of 2010-2014. One of sub district mostly affected by drought is Paranggupito. Paranggupito subdistrict is about 55 Km from Wonogiri Regency’s downtown. This subdistrict is the southernmost one in Wonogiri, between two Provinces: East Java and Daerah Istimewa Yogyakarta. Paranggupito subdistrict consists of 8 villages, all of which are affected by drought. Three villages were established to be DESTANA standing for Desa Tangguh Bencana (Disaster Resilient Village) belonging to Pratama classification. Those villages are Ketos, Johnut, and Gendayaan. As suggested [4], this status assignment by Wonogiri Regional Agency for Disaster Management is because the three villages have high vulnerability to drought disaster.
Climate change also affects strongly the farming sector of Paranggupito Sub District, particularly the rain-fed land very vulnerable to long dry season, one of which is Ketos Village. Water supply in rain-fed land is determined by rainfall condition. The farmers’ vulnerability to drought is determined by the interaction between potential effect of climate change and farmers’ adapting capacity. Potential effect or impact is the resultant of farmers’ sensitivity and exposure to drought or very inadequate water supply. Considering the background elaborated, drought is one of problems the farmers often encounter in Ketos Village, Wonogiri. Monographic data of Ketos Village in 2019 [5] indicates that the village’s farming lands are all dry land, 640.42 Ha wide, consisting of moorland (587.02 Ha) and yard (53.4 Ha). Ketos villagers’ basic livelihood, according to Village’s Monographic data of 2019, is majority (77.76%) farming.

Adapting attempts the farmers have taken is to resist drought. Each of adapting measures taken by the farmers will affect the behaviour to take such adapting measure. Topographic condition of region and natural resource, particularly insufficient water supply, and the people’s interestedness in farming realm as the majority of people’s livelihood in Ketos Village are interesting to study in this research. Therefore, the problem then generates adapting behaviour among farmers in the attempt of maintaining their farming. This research aims to analyze the adapting strategy the farmers of Ketos Village take in the attempt of dealing with drought.

2. Method
This research employed qualitative research method. Informant of research was determined using certain criteria: people with farmer profession and having worked as farmers for at least 10 years as in Table 1. The criteria were selected based on adaptation and mitigation in farming sector as the unit of analysis and assumption that the people having worked in farming for 10 years have experienced drought occurring in their region. The assumption is based on an argument [6] that drought is creeping disaster or the one not occurring suddenly. Informants were selected using purposive and snowball sampling techniques with the criterion that the farmers have been affected by drought in Ketos Village, Paranggupito Sub District, Wonogiri Regency (see on Table 1).

| No | Informant                                      | Information Explored                                                                 |
|----|-----------------------------------------------|-------------------------------------------------------------------------------------|
| 1  | Farmers of Ketos Village (Main Informants)    | Farmers’ adapting behaviour to limited water in farming activity                    |
| 2  | Chairperson of Farmer Group (Key Informant)  | Farmers’ behaviour (Head of Farmer Group’s point of view), dry-land farming system of Ketos Village, role of farmer group in dealing with limited water, and general effect of limited water on the farming activity of Ketos villagers |
| 3  | Agricultural Extension Officer for Ketos Village (Main Informant) | The role of agricultural extension officer and activity it conducts in coping with the effect of drought on farming |
| 4  | Head of Village Development Affairs Division (Main Informant) | Short- and Medium-term policy and program of Ketos Village in dealing with limited water |

Source: Analysis, 2021

The strategy used was case study. Case study can be used to develop critical thinking ability and to find new solution to one topic studied [7]. Primary data was obtained through Focus Group Discussion (FGD), in-depth interview, and participatory observation. Forum group discussion (FGD) is a systematic process of collecting data and information specifically on a certain problem through group discussion [8]. This research employed FGD activity along with some representatives of farmer
groups existing in Ketos Village to obtain primary data on the analysis of effect and adapting strategy taken by farmers in dealing with limited water.

Data validation was conducted using source and method triangulations. Technique of processing data using triangulation is the technique of validating data utilizing something other than the data as the comparator of data. In this research, data source triangulation was conducted by crosschecking the data obtained through several sources. Method triangulation was conducted to crosscheck the use of data collecting methods including interview, participatory observation, and documentation study simultaneously on the same source. The value of triangulation lies on the provision of evidence—whether convergent, inconsistent, or contradictory [10]. Technique of validating data using triangulation can be illustrated in Figure 1.

![Figure 1. Technique of processing data using source and method triangulation.](image)

### 3. Results and discussion

#### 3.1 Effect of water restriction in farming in Ketos Village

Long dry season affects plant growth adversely because all physiological activities such as photosynthesis, respiration, transpiration, growth rate and ultimately crop production are disrupted [11]. The air impacts felt by farmers in Ketos Village can be classified into impact groups: biophysical impacts and socio-economic. The biophysical impact on farming, where there is an increase in pests, especially uret, an increase in the number of weeds or weeds, and changes in both quantity and quality that have an impact on the effectiveness of production. The impact in the socio-economic aspect of farmers has an effect on decreasing production due to the erratic rainy season, thus catching up with the rainy season. Fluctuation occurs in the paddy of agricultural products, and the existence of rural youth working in the city during the dry season. There is a change in farmer household assets (development in the field of animal husbandry as a form of investment when the dry season arrives and cultivating the annual crops of Sengon Albasisa and Teak). "The Asset Vulnerability Framework" according to [12] includes various asset managements that can be used to carry out or develop strategies that can sustain viability.

#### 3.2 Short-term adaptation strategy taken by farmers to deal with water limitation in Ketos Village

Various attempts have been taken in the agricultural sector in response to climate change including drought in Ketos Village. It is generally aimed at minimizing climate-related risks, in the sense of increasing resilience and reducing vulnerability to unfavourable climatic conditions [13]. This is because the increase in drought frequency has a negative impact on local production, especially in areas prone to water shortages. The strategy of managing planting environment is carried out through some attempts: farmers’ planning and adaptation to their farming, using the following short-term adapting strategy approaches.

##### 3.2.1 Planting time planning

Local weather forecasts or "Pranatamangs" is used to determine the date to start planting season which has become a method of calculating the coming of planting period by farmers in Ketos Village.
Farmers have been able to predict, if older people have started planting, other farmers will join the planting. Its characteristics can be seen from the presence of natural signs: If the sound of the Srigunting Bird comes from the east, rainy season will begin, and therefore simultaneously the Ketos Village farmers will start planting.

3.2.2 Selection of planting varieties, local superior seeds tolerant to drought conditions
Paddy is a plant very vulnerable to water availability. Paddy is still a popular commodity for the people of Ketos Village. Prior to 2000, Ketos village farmers cultivated upland paddy, a type of paddy that is often grown on dry land areas. However, along with the progress of farmers' knowledge, in 2000s Ketos Villagers began to recognize a new paddy variety, namely "Segreng Handayani". Segreng is red paddy of a new local superior variety (VUB) which is very adaptive to water limitations. The choice of this red paddy variety is quite profitable because in addition to not requiring a fairly high watering intensity, it is also resistant to drought, and has a short lifespan of 100 days. The topography of Ketos Village, which is sloped, is very suitable to plant Segreng variety. Segreng is the farmers’ favourite paddy variety, because it is resistant to pests compared with other paddy varieties that are not suitable for planting in the Ketos Village area. As for the Segreng type paddy also having a high selling value, it is not surprising that farmers often exchange the segreng paddy harvest outcome with the cheaper white paddy for family consumption. Segreng paddy can grow in various agroecologies and soil types. Meanwhile, the main requirements for the growth of Segreng paddy are suitable soil and climatic condition. Climatic factors, especially rainfall, are factors determining the success of cultivation. This is because the water requirement for Segreng paddy relies on rainfall only. It means that segreng paddy is indeed resistant to drought stress.

3.2.3 Application of intercropping planting system
Since the last few decades, the implementation of the community planting system in Ketos Village has changed. Departing from the monoculture cropping system, it changed into intercropping. Intercropping system is an anticipative measure in the case of crop failure due to drought or catching up with rain. The application of intercropping and intercropping cropping systems based on the water needs of each plant has a very significant impact on farmers. The intercropping system applied is intercropping between paddy - corn – cassava can be illustrated in Figure 2. The intercropping system and different crop rotation means that it has increased the diversity of flora, this will also be followed by an increase in the diversity of fauna, both as pollinators, natural enemies of pests, and other useful faunas [14].

Figure 2. Application of intercropping planting system.

3.2.4 Cropping Pattern
Through a cropping pattern that is anticipatory measure taken to respond to water supply, a number of farmers are able to achieve fairly high productivity, so that their farming income can increase
considerably. In the month when the rainy season starts, namely October, farmers have started planting paddy using the "ngawu-awu" technique, intercropping with corn and cassava. Paddy and maize will be harvested on January / February. It is followed with planting peanuts on February and harvesting on April. In a year with an estimated long rainy period, the peanut planting period can be done twice. The outcome of harvest in planting period-1 in the first 3 months is used as seed for the next 3 months of planting, and the rest will be sold. Meanwhile, during the second planting period, the whole produce will be sold. On July-August farmers will wait for the outcome of cassava harvest. This includes changing the planting time in order to obtain optimal growth [15].

3.2.5 Drought tolerant cultivation techniques
"Wana" is what Wonogiri farmers call their agricultural land in the form of dry (rainfed) agricultural moor, in which there are typical paddy planting techniques, local wisdom of southern or dry land farmers. The hereditary tradition of "Ngawu-awu" is a way for farmers in Ketos Village to welcome rain. Generally, paddy is planted by spreading it, even spreading the seeds before the rainy season arrives. This method is called "ngawu-awu" in order to save time. The "ngawu-awu" activity where farmers sow paddy seeds on dry land that has been processed manually or using farming tools, namely rakes. The soil is processed by turning the dry soil so that there are no more traces of cracks caused by drought. The "ngawu-awu" process will be considered successful if the rain comes timely. According to the Javanese calendar, it is the right time for the farmers to do the “ngawu-awu” process.

3.2.6 Land intensification and continuous monitoring
The land intensification was carried out due to the limited land of the farmers. Farmers regularly apply organic fertilizer / manure from their respective household livestock as basic fertilizer. Ketos Village farmers also buy sack organic fertilizer on the principle that even though it is expensive but the results are good, the fertilizer will be purchased. The use of chemical fertilizers (Urea, NPK, Phosphat) is also widely used because of information, offers or promotions from agents who often come at farmer group meetings. Good soil cultivation aims to form a root system. A good root system will ensure optimal absorption of water and nutrients in the soil. Optimal absorption of water and nutrients will ensure high plant quality. Soil processing is carried out routinely; the term tillage in Ketos Village is "diwalik / diluku / dibrujul". After the first rain fell, just before planting the first crop, the soil was dibbled or paliran is made. For the next crop, the farmers do not need to plough the soil anymore. The use of tools in soil cultivation depends on the thickness of the soil solum. Hoe only is enough to be used on the land with a thin solum. Such technology is compatible to the recommended technology in sustainable agricultural systems, which is also recommended in dry-land farming in India [16]. Maintenance is also carried out by continuously monitoring the attacks of pests, diseases and nuisance plants or often referred to as "Ndangir" can be illustrated in Figure 3.

Figure 3. “Ndangir” or plant maintenance and continuous monitoring.
3.3 Medium term adaptation strategy taken by farmers to face water limitation in Ketos Village

The strategy of managing planting environment can be carried out through various planning and adjusting efforts, both in agricultural activities, resource management and the application of agricultural technology to overcome the impacts of climate change and anomaly, namely drought [17]. The farmers take the following medium-term adapting strategies:

3.3.1 Economic adaptation

Some attempts have been taken by farmer communities that are affected by water shortages in relation to the economy, where farmers borrow money from Gapoktan (Farmer Group Association) as a capital loan in running their farming. Another adaptation strategy is the existence of “Tandon Pangan” where many people still have foodstuffs, so they do not worry about food shortages. They rely on past agricultural savings, as a form of anticipation when the dry season arrives.

3.3.2 Empowerment of farmers through building and facilitation

There were representatives of Ketos Village farmers who had participated in PMD (Empowerment of Village Communities) regarding TTG (Expedient Technology). On this occasion, they discussed the cultivation of herbal chilli plants that can grow on rocks (specific location varieties) in Ketos Village. The harvest time is long enough to make farmers less interested in cultivating it. Department of Agriculture provides facilitation in consultation with the Field Agricultural Extension Officer, but only limited to farmers’ problems in their farming.

3.3.3 Use of slopes

Ketos Village has a variety of topographical conditions. Data of Ketos Village’s Profile in 2019, the topography of village consists of lowland (269.00 Ha), hilly (107.00 Ha), highland or mountain (120.00 Ha), and slope (0.20 Ha) can be illustrated in Figure 4. In slope-to-bumpy land conditions, a roll terrace is constructed. On the embankment or terrace lip there are grass plants as animal feed. On the sloped terrace, other drought-tolerant commodities are planted, such as rhizomes (turmeric, ginger, etc.), gudai beans, and herbal chilly can be illustrated in Figure 5.

![Figure 4. Landscape of Ketos Village (left: low land, right: rocky slope).](image1)

![Figure 5. Rhizome plants and gudai bean as the utilization of slopes.](image2)
4. Conclusion
Climate change affects strongly the farming sector of Paranggupito Sub District, particularly the rain-fed land very vulnerable to long dry season, one of which is Ketos Village. The impact is divided into biophysical and social-economic ones. Adapting attempts the farmers have taken are their form of resistance to drought. Adapting strategy taken is the short-term one including: (1) Planning the planting time, (2) selecting plant variety, local superior seed tolerant to drought condition, (3) applying intercropping system, (4) cropping pattern, (5) drought-tolerant cultivating technique, and (6) land intensification and continuous monitoring. Meanwhile the medium-term adapting strategy includes (1) economic adaptation, (2) farmers’ empowerment through building and facilitation, and (3) utilization of slope land.

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