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Introduction of ICoFA 2019

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Abstract

Increasing global population is inevitable and this will bring a number of challenges including the need for more food. On the other hand, good ecosystem services are vital for human being. In the future, provision of high quality and sufficient amount of food have to be accompanied by healthy ecosystem. Hence, contribution of applied sciences and technology is expected to elucidate that situation. Following successful of the first conference, the second International Conference on Food and Agriculture (ICoFA) will be conducted to address the theme of "Contribution of Applied Sciences and Technology to Food and Agroecology". The conference will gather scientists, researchers, students and practitioners to discuss essential topic in food and agroecology. ICoFA is dedicated to present high quality researches delivered by reputable keynote speakers as well as invited speakers from Asia region.

The 2nd International Conference on Food and Agriculture will be held on 2 – 3 November 2019 in Nusa Dua, Bali, Indonesia. Hosted by Politeknik Negeri Jember, the event is intended to provide technical forum and research discussion on food, agriculture, and how technology is effectively employed for sustainable development of food and agriculture. The conference will cover a series of presentations and discussions in plenary, concurrent and poster sessions. It is aimed to bring researchers, academicians, scientists, students, and practitioners together to participate and present the latest research findings, developments, and applications related to various aspects comprising agriculture engineering and biotechnology, organic agriculture, agroindustry and agribusiness, animal nutrition, animal production, and veterinary science, food science and technology, food safety, food security and sovereignty, IT for agriculture, renewable and novel energy sources and other topics related to food and agriculture.

The conference was participated by 215 participants from whole part of Indonesia from Sabang to Merauke, from Korea, Malaysia, India, Pakistan and The Netherlands. There are 205 papers for oral presentations and the committee has selected 68 papers out of 205 papers to be published to IOP Conference series : Earth and Environmental Science.

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in recognition of valuable contributions
Nusa Dua, Bali, November 2nd - 3rd, 2019

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Maize yield in a dryland area as affected by rainfall variability

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Abstract. This study aimed to report maize yield in a dryland area of North Lombok as affected by rainfall variability. A three-year study was conducted during a period of maize growing season (December to April) in 2015/2016, 2016/2017 and 2017/2018 in Gumantar village, North Lombok. Daily rainfall data was collected from a rain gauge installed in one of maize farmers' land. Estimation of drain upper limit and crop lower limit was done based on gravimetric method. Hand-held core kits were used to collect soil samples at 0-15cm, 15-30cm, 30-60cm depth at sowing, fast vegetative growth stage (35 days after sowing=DAS), grain filling stage (85 DAS), and at harvest. Maize yield data were collected from 20 farmers that all grew maize as main crop and legume crop (ground nut or mung bean) as secondary crop. There was great rainfall variability in term of the beginning of rainy season, volume and distribution of the rain as well as the occurrence of dry-spell period resulted in great maize yield variability. The highest maize yield recorded was 8.4 ton/ha and the lowest was 0.6 ton/ha. Growing legume crop in addition to maize can be a good practice in dryland area to avoid total yield loss.

1.Introduction

Lombok is one of the islands in Indonesia that is located in the province of Nusa Tenggara Barat (NTB). The island is categorized as a small island with an area of just over 4000 km2. The climatic conditions vary from B1 to E4 according to Oldeman classification [1]. As the other small islands, Lombok relies heavily on rainfall as the main source of fresh water, especially for agricultural purposes in dryland areas. North Lombok is a district with the largest dryland area in the island and uses over 50% of its dryland for agricultural purposes and the rest is mainly forest area. Maize is the major annual crop grown in the area and its yield has been closely affected by rainfall. The physiological process of plants grown in dryland areas is not only determined by the total amount of rainfall but also by its intermittent and magnitude [2].

The changes in rainfall pattern reported recently has many been associated with climate change [3]. The change in pattern includes rainfall variabilities in the season, such as more extremes for both too much or too little that leads to droughts or flooding, a shift in rainfall period, including time of the start or the end of the rain period as well as duration of the rain. In the tropics, the rainfall change can be very extreme, reaching 70% below the normal rain level during the rainy season [4; 5]. In North Lombok itself, the predicted rainfall in 2060 during the maize growing season (December to April) will decrease by 5 to 20% [6]. Those changes reported earlier provide a very important information, especially for researcher and dryland farmers to be able to develop management strategy, such as crop and variety selection, planting time and culture management.

Maize farmers in the dryland of North Lombok are mainly poor farmers and they only able to grow maize once a year, in the rainy season only. Generally, poor farmers difficult to adopt a good maize cultivation technology because the technology requires high costs. Another problem is that they have not been able to adapt to climate change because they do not have sufficient knowledge and money. To improve the welfare of the dryland farmers by adopting a good and correct maize cultivation technology and being able to adapt to climate change, an intervention was carried out by researchers from The University of Mataram (UNRAM), Lombok. The intervention has been to build partnerships between farmers-banking-seed entrepreneurs-fertilizer distributors. In this partnership, farmers have received business capital from a bank to be able to apply a recommended technology from UNRAM. Seed companies have provided quality hybrid maize seeds in the right amount at the right time. Likewise with fertilizer distributors, provide fertilizer in the right amount and time. This partnership program was started in the rainy season of 2015/2016.

After 3 years of the program, not all maize farmers have got the expected results. The problem was that there have been a high variation in rainfall in the last 3 years. Variations occurred not only in total during the growing season, but also in magnitude and intermittent of the rainfall. This paper reports the dynamics of rainfall in the dryland of North Lombok and its effect on crop yields, especially maize.

2.Materials and method

2.1. Materials

The study was conducted at Gumantar Village, Kayangan District, North Lombok Regency, West Nusa Tenggara (NTB) starting in the 2015/2016 rainy season until the rainy season of 2017/2018. Most of the lands in Gumantar have sandy loam to loam textures with low organic matter content. Climate type in the study area according to Oldeman classification is type D3, means that the area has only 3-4 months of wet season [1]. Maize is the main crop grown by farmers during the rainy season. In addition to maize, some farmers also grow legumes, such as cowpea, peanuts, green beans, and long yard beans. The land area for agricultural business activities of the respondent farmers varied from 0.5 to 3.0 ha with an average of 1.29 ha.

2.2. Methods

2.2.1 Respondent determination. The survey was conducted on 20 maize farmers who participate in a partnership program organized by The University of Mataram. A simple random sampling technique (selection without any plan or system) was used to select the respondents. A well-structured open ended and close ended questions were put in an instrument. Questions were asked farmers' on type of crops they were growing, the growing area and the yield of each crop in the three consecutive years. There were no special considerations in randomly choosing 20 maize farmers as respondents except that they were the first group to get an approval from a bank to receive low interest loans at the start of the partnership program (rainy season of 2015/2016). Survey activities were carried out in June 2016, 2017 and 2018 after all respondents sold their crops yield.

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2.2.2. Water characteristic of the soil. A gravimetric method was carried out to determine water characteristics of the soil where the maize was planted (at one of farmers' field) at certain depths (15, 30, 45 and 60cm) during sowing, during the fast vegetative phase (35 days after sowing = DAS) and at grains filling phase of the cob (85 DAS). Maize seeds in this site were sown on 26 January 2016 and the harvest was on 10 May 2016. There was no rain from the end of April 2016 until the harvest date and hence, the rainfall data presented in this paper is up to April month only. Soil samples were taken using hand-held coring kits at 0-15cm, 15-30cm and 30-60cm depths. Observation for soil water characteristic was only carried out in the 2015/2016 rainy season and at one farmer's location. The type of soil at the sampling location was Inceptisol with a sandy loam texture. The soil chemical properties were as follows: 0.46% organic matter, 0.05% N total (Kejdhal), available P 8.42 ppm (Olsen) and exchangeable K 0.49 me%, pH 7.0.

2.2.3. Determination of DUL and CLL. Estimated values of drained upper limit (DUL) or field capacity and crop lower limit (CLL) were conducted three times, at sowing, 35 DAS and 85 DAS. The estimations were done by using the collected rainfall data and gravimetric soil moisture contents [7] from the observation location as well as using a soil profile in Australia with a sandy loam texture that fitted with soil moisture data collected from North Lombok. With a soil bulk density data, the gravimetric water content then could be converted to volumetric water content using Microsoft Excel. Rainfall data from a rain gauge installed in Gumantar was observed daily during the three maize growing seasons.

3.Results and discussion

3.1. Rainfall variability It was a great variability in rainy days and rainfall total during the maize growing season in Gumantar village in the three consecutive years of observation. The highest variation occurred mainly during December and April months, especially in the rainfall total values (Table 1). An extreme low of rainy days and rainfall total was recorded in December 2015 but the rainfall then increased significantly in the following months (January and February 2016). In the month of January, the lowest rainfall was recorded in 2017 but that year got the highest number of rainy days that made a good distribution of rainfall within the month. A rather extreme rainfall total (700mm) was recorded in February 2016, and this amount was more than double of that in 2017 and 2018 in the same month. Earlier study indicated that excessive rainfalls caused significant loss in maize yield [6] and in North Lombok, the loss was mainly due to hails and storms. On the other hand, during March and April months, the year of 2017 received the highest rainfall compared to the other years. High rainfall in December, March and April during the maize growing season of 2016/2017 resulted in the highest rainfall total among the three years of observation. All of the information presented earlier show the important of climate variability information to dryland farmers in order to decide when to sow their maize seeds. A shortage of rainfall in December, such as in 2015 might cause poor early establishment of maize [8]. Table 1. Number of rainy days and rainfall total during the three consecutive years of maize growing months in Gumantar village, North Lombok Year Month 2015/2016 2016/2017 2017/2018 December Rainy days 4 14 12 Rainfall total (mm) 17 326 174 January Rainy days 12 17 20 Rainfall total (mm) 515 426 409 February Rainy days 17 11 13 Rainfall total (mm) 700 300 301 March Rainy days 13 9 9 Rainfall total (mm) 125 289 131 April Rainy days 6 9 4 Rainfall total (mm) 74 257 56 Total Rainy days 52 60 58 Rainfall total (mm) 1,431 1,598 1,071

Rainfall total during the maize growing period of 2015/2016 was sufficiently high as compared to those in 2017/2018. But for farmers who sowed their seeds on a sandy loam soil in December for the maize growing year of 2015/2016 might experience severe maize yield loss due to germination failure or crops damage during the early establishment stage. To make a successful sowing, a rainfall total of minimum 25mm with three rainy days is needed [9]. Some farmers who were able to purchase seeds then replanted their crops in January 2016. Farmers who replanted their crops or started to sow maize seeds in January 2016 experienced a good growing season because the rainfall was distributed evenly and met the water requirement during the important stages of maize development, such as at germination, high vegetative growth and at grain filling stage as seen in Figure 1. 3.2. Effect of rainfall variability on water characteristic in the soil and yield of the crops At sowing, it was sufficient water available at 15cm depth to promote germination. The volumetric water content (VWC) at this stage was within CLL and DUL to ensure a good germination. When the crops grew bigger and the roots went deeper during the high vegetative growth stage (35 DAS), the VWC at 30cm depth was at an optimum of 19.5%, very close to DUL (21%). During the grain filling stage (85 DAS), the VWC at 30cm depth was 17.0% and 20.2% at 15cm depth. These data showed that maize crops that were grown in the soil sampling area had sufficient extractable water during the whole of its growing period. At harvest, the VWC of the soil was very close to CLL at all soil depths and this condition was expected to ensure a good harvest quality of the cobs. 0153045600 5 10 15 20 25 30 35 40 45 50 55 60Depth (cm)Volumetric Water (%)DULCLLNorth Lombok-sowingNorth Lombok-35DASNorth Lombok-85DASNorth Lombok-harvestFigure 1. Drain upper limit (DUL) and crop lower limit (CLL) during a growing season of 2015/2016 at one of the farmers' land in Gumantar, North Lombok The high rainfall variabilities in the months of March and April as presented in Table 1, might cause severe loss to maize yield. Those farmers who planted their crops on a sandy loam in December for the year 2015 or 2017 might experience yield loss more than those who planted their crops on a loam soil in the same year because loam soils hold water better than sandy loam [10]. March and April were months when the maize crops in North Lombok entered silking and grains filling stages. As we all aware, at silking and grain filling stages the crops must receive sufficient water. Failure to meet sufficient water demand during these two critical stages can cost a high yield loss to the maize crops [11]. An incidence of severe water stress during silking and grain filling stage was observed during the maize growing period of 2016/2017 (figure 2). A prolonged dry-spell spell occurred from 13 February to 11 March 2017. For those crops planted in December 2015 or 2016, especially those grown on a sandy loam soil, experienced almost total loss of the maize yield (Table 2). Crop replanting was also performed by some farmers for those who planted their maize seeds in December 2016 during the 2016/2017 maize growing period.

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01-Dec08-Dec15-Dec22-Dec29-Dec05-Jan12-Jan19-Jan26-Jan02-Feb09-Feb16-Feb23-Feb01-Mar08-Mar15-Mar22-Mar29-Mar05-Apr12-Apr19-Apr26-AprDaily rainfall (mm)2015/20162016/20172017/2018Figure 2. Rainfall variability during the three consecutive years of maize growing period in Gumantar village, North Lombok The high rainfall variabilities during the three observed growing seasons of maize resulted in a high variability in maize yields (Table 2). The highest maximum maize yield as well as the average yield was recorded in the growing season of 2015/2016. However, the lowest minimum yield was also recorded in the same season. The highest maximum yield of maize that greater than 8.0 ton/ha is considered as high for a dryland area, compared to those obtained in South Sulawesi [12]. The data showed great discrepancies in maize yield obtained in every growing season that mainly determined by timing of sowing in

relation to the availability of rain water (amount and timing) following the sowing [13]. Failure to sow the maize seeds at the appropriate time resulted in enormous yield loss. Farmers need to have knowledge and money to be able to adapt to climate change that causes rainfall variability. Unfortunately most dryland farmers in North Lombok are small and poor farmers. Small and poor farmers do not have sufficient knowledge, financial and institution to adapt to climate change. Some farmers experienced yield loss due to a poor early crops establishment (shortage or excessive of rainfall) and some were due to poor fertilization or bad grains filling due to rainfall shortage or a dry-spell period. Table 2. Maize (grains) and legumes (pods) yield in the three consecutive years of maize growing months in Gumantar village, North Lombok Year Yield (ton/ha) 2015/2016 2016/2017 2017/2018 Maize Average 4.7 3.7 4.3 Maximum 8.4 6.8 8.0 Minimum 0.6 1.0 1.2 Standard Error 0.45 0.35 0.40 Legume Average 2.2 1.6 1.0 Maximum 5.6 5.4 2.1 Minimum 1.0 0.3 0.1 Standard Error 0.26 0.25 0.60 Growing legume crops, such as ground nut and mung bean as a secondary crop in addition to maize has been a good adaptation strategy to spread the risk of total main crop yield loss because of climate change or rainfall variability. Table 2 shows that the rainfall in the growing season of 2015/2016 had able to produce as much as 5.6 ton/ha pods of ground nut combined with mung bean with a minimum production of 1.0 ton/ha. Unfortunately, in the growing season of 2017/2018, the legume crops yield

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was the lowest due to insufficient water available during the legume growing period (only 197ml of rainfall total compared to 546mm in 2016/2017 and 269mm in 2015/2016). Legume such as ground nut requires 228.9mm of water seasonally to produce good yield [14]. Farmers in North Lombok started to grow ground nut or mung bean in late February to avoid rainfall during the harvest period. 4.Conclusion There was a great rainfall variability during the three consecutive years (2015/2016, 2016/2017 and 2017/2018) of maize growing season in dryland area of Gumantar, North Lombok. The rainfall variability affected maize yield greatly due to water availability for maize to grow and to yield. Both a shortage or excessive rainfall during the early establishment of maize and dry-spell during the grain filling stage caused severe loss to the maize yield. Adaptation strategies need to be developed, such as to diversify and to grow adaptive crops to avoid total yield loss.

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