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SUITABILITY ANALYSIS OF SORGHUM BASED ON RAINFALL AND LAND CONDITIONS IN GUNUNGKIDUL, INDONESIA

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ABSTRACT

Sorghum is a grain, forage, or sugar crop and it is more suitable to be cultivated on dry land or paddy fields during the dry season since it has a vegetative period of rapid and easily expandable without requiring a lot of water. Moreover, sorghum has a high productivity, with low risk of failure, low cost, and pest resistant plant and it can be used as an alternative food for the community or could be used as biofuel. Gunungkidul, Yogyakarta, Indonesia has a lot of unused and marginal land, such as drought-prone areas, acid soil and saline soil, as well as other non-productive lands that has a potential to grow sorghum in order to overcome the scarcity of forage in the area when the dry season occurred. In this study, suitability of sorghum based on the characteristics of land conditions and rainfall was analyzed by overlaying maps of sorghum suitability over the area of interest. Since sorghum has an ability to adapt in dry condition and it has a wide benefit for human, this study suggest that sorghum has a potential crop for food diversification in changing the climate.

Keywords: Changing climate, sorghum, suitability, map, rainfall

1 INTRODUCTION

Sorghum is a versatile crop and very resistant to dry soil conditions as it originally comes from the region around the Niger river in the East Africa with dry climate or semi-arid (Toure et al. 2004; Borrell et al. 2005). Sorghum is potentially developed over the broad area, covering dry climates or short rainy season as well as areas with poor soil conditions. Sorghum has a vegetative period of rapid and easily expandable without much water. Furthermore, the nutritional content of sorghum is comparable to rice and corn. Protein, Calcium, and Vitamin B1 in sorghum are more than rice and corn, while calorie and carbohydrate are nearly the same. However, sorghum contains less fat than the other two priority crops (Department of Health, Directorate Nutrition 1992). It shows that the composition of the three main nutrients between sorghum and rice are nearly equivalent and even better.

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Sorghum is a high productivity crop and efficient in conversion of solar energy and use of water. The average age of sorghum to harvest has reached four months since the planting season. There is even a variety of it from Bangladesh that could be harvested in 80 days, which is shorter than the age of the corn and rice. Sorghum development is projected to overcome the problem of scarcity of forage in Gunungkidul in the dry season as a forage for feeding livestock. Sorghum can also be used for food diversification, bioenergy as well as for industrial, ethanol, paint, plastic biodegradable plastics and modified starch. Sweet sorghum is a type of sorghum that contains fairly-high sugar content and could be squeezed for sugar (syrup) and bioethanol (ICRISAT 1990; Reddy et al. 2007). Another advantage of sorghum is its high-productivity, with low risk of failure, relatively low in the farming fund and which is more resistant to pests and diseases than other crops. Since it has a variety of advantages, sorghum is a potential crop for food diversification in changing climate.

In Indonesia, sorghum is not included as a priority crop such as rice and corn that have been cultivated over almost all of the region. However, five largest regions that produce sorghum are Central Java, East Java, Special Region of Yogyakarta, West Nusa Tenggara, and East Nusa Tenggara. Unfortunately, the productivity of sorghum in Yogyakarta is the smallest among others (Sirappa 2003). In Yogyakarta, Gunungkidul is the largest cultivation area with 870 ha compared to Sleman, Kulonprogo, and Bantul with only 6, 10, and 52 ha, respectively (Subagio 2013). A hypothesis to answer this question is that farmers have not been able to optimize the yields of sorghum because of the difficulty in determining a suitable area to grow sorghum.

In this paper, the suitable area for sorghum cultivation was analyzed based on climate and land conditions in Gunungkidul, Yogyakarta. Climate condition is represented by yearly rainfall average while soil type and land slope act in place of soil condition. As an alternative crop, sorghum cultivation in unused and marginal land will be survived in dry season and can add food production for Gunungkidul, Yogyakarta.

2 DATA ANALYSIS

Based on Djaenudin (2003), the suitable criteria for sorghum are classified into five classes: Very Suitable (S1), Suitable (S2), Marginally Suitable (S3), Not Suitable Currently (N1), and Not Suitable Permanently (N2). The criteria described in Djaenudin (2003) rely on many factors, but in this study, three factors are considered: rainfall, soil type, and land slope. Furthermore, rainfall and land-slope were analyzed by two-way ANOVA.

Rainfall data collected from Indonesian Agency of Meteorology, Climatology, and Geophysics (BMKG) of Yogyakarta from December 2006 to June 2011 over 18 sub-district in Gunungkidul. Based on those data, isohyet map was constructed as in Figure 1. It seems that the Southeastern part of Gunungkidul received the highest rainfall per year over the period. Soil type and land slope data were collected from Development Planning Agency at

Sub-National Level (BAPPEDA) of Yogyakarta a mapped into soil type and land slope map as in Figure 2 and Figure 3, respectively, and shows that more than 40 degrees of land slope existed on Southwestern and Northwestern part of the region.

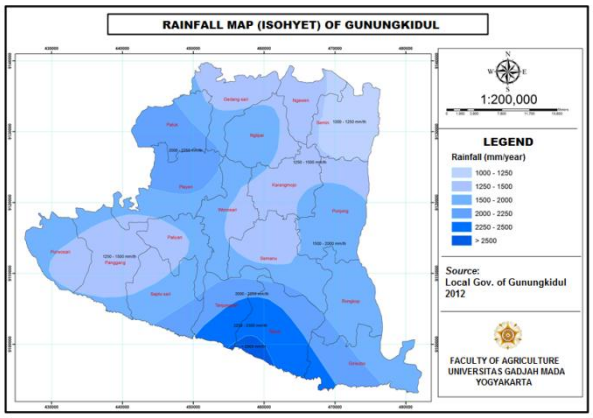

Figure 1. Rainfall map of Gunungkidul

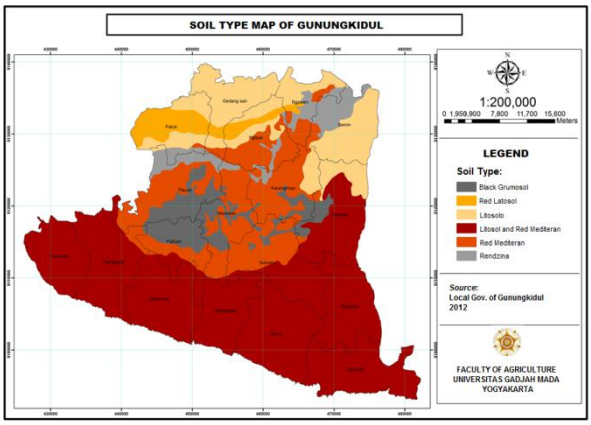

Figure 2. Soil-type map of Gunungkidul

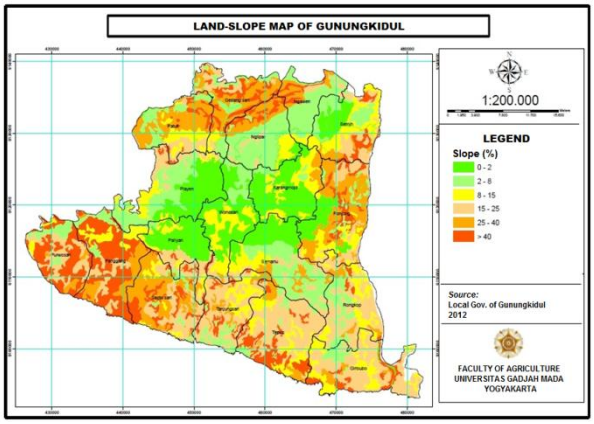

Figure 3. Land-slope map of Gunungkidul

3 ANALYSIS OF VARIANCE

Based on climate, land, and production, it obtained a two-way analysis of variance with an assumption that the distribution of sorghum crop production in each region of Gunungkidul evenly spread resulting in a two-way ANOVA mixed effects models:

1. Test of interaction; significant value for the interaction between rainfall variables with land type 0 (<0.05) then H0 is rejected, which means there is no interaction between the two factors, soil type and rainfall.
2. Test the effect of soil type factor; for this type of land acquired significance value 0.583 (>0.05), then H_0 is accepted, which means a factor of land types do not significantly affect the amount of sorghum production.
3. Test the effect of rainfall factor; for rainfall significance value 0338 (>0.05) then H_0 is accepted which means no rainfall factors significantly affect the amount of sorghum production.

The rainfall factor is fixed factors and analysis of variance results showed that rainfall does not significantly affect the amount of sorghum production. These results are consistent with the characteristics of sorghum plants that do not depend on the level of rainfall. Thus, in the other word, sorghum is likely to adapt to different rainfall conditions in Gunungkidul. From the analysis above, it can be concluded that rainfall does not affect the sorghum crop production. Thus, sorghum plantation can be focused on land that cannot be planted with rice, either permanently or temporarily.

4 SUITABILITY MAP OF SORGHUM IN GUNUNGKIDUL

This section presents the suitability of sorghum to be cultivated over Gunungkidul based on rainfall, slope, and soil type (Figure 4). Furthermore, the results of this analysis are combined with cultivation area taken by field surveys and are presented in Figure 5.

Based on the type of land, almost the entire area in Gunungkidul has all kinds of the land slope. Since sorghum enables to grow on these lands, it can be said that sorghum can be planted in Gunungkidul. It can be seen that almost all regions of Gunungkidul, sorghum can be planted except for region Panggang. Land in this area is less suitable given sorghum planted most of its territory in the form of a rocky hill and has a slope that is quite extreme.

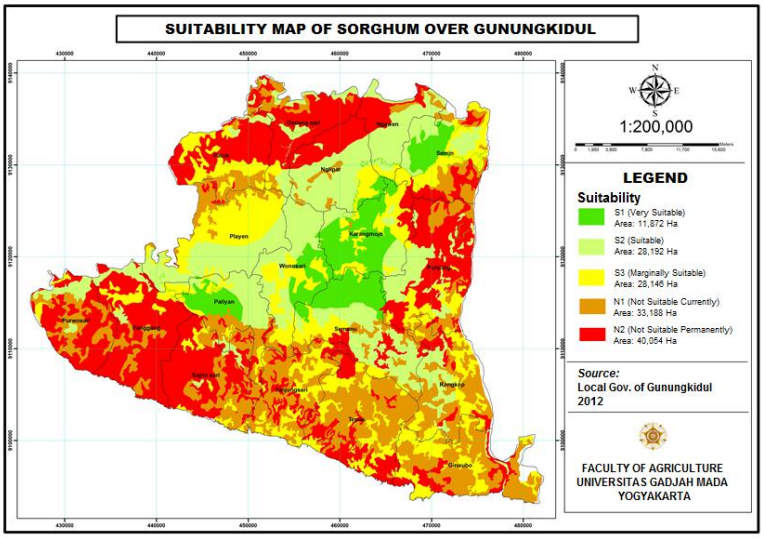

Figure 4. Suitability map of sorghum over Gunungkidul

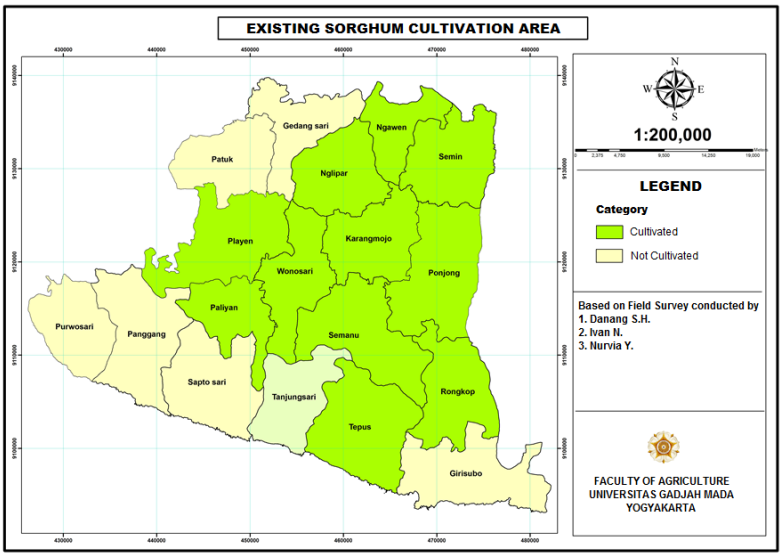

Figure 5. Existing cultivation area of sorghum over Gunungkidul

5 CONCLUSIONS

Based on the analysis of the characteristics of sorghum plants conditions in Gunungkidul, we conclude the following:

1. Low productivity of sorghum in Yogyakarta is a result of inappropriate cultivation area, especially in Gunungkidul which is the largest area of sorghum cultivation.
2. Rainfall is not a limiting factor for sorghum in Gunungkidul, it proves that sorghum is drought tolerant crops.
3. Based on land condition, 28.32% area of Gunungkidul is Not Suitable Permanently for sorghum cultivation, however, farmers still plant the sorghum on those areas.
4. In order to increase the productivity of sorghum, it should be cultivated over S1 and S3 classes, so if the farmer still wants to cultivate sorghum in Semin, Ponjong, Rongkop, and Tepus, they should cultivate it with caution since those areas are included in Not Currently and Permanently Suitable.
5. As an alternative, sorghum is one of grain crop which is more suitable to be cultivated on dry land or paddy fields during the dry season.

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