The adaptation test of hybrid maize (*Zea mays* L.) varieties on ex-coal mined land in Kutai Kartanegara

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Abstract. New Superior Varieties are one component of technology to increase the productivity of food crops. Ex-Coal Mined Land is marginal land, and can be used for agriculture by applying location-specific technology. The purpose of this study was to determine the performance and productivity of hybrid corn: Bima-20, Bisi-2, NK-22 and Nasa-29 on ex-coal mining land. The study was conducted on the ex-coal mined land in Kutai Kartanegara Regency, East Kalimantan Province from April to July 2018. The technology applied was through Integrated Crops Land Management (ICLM) and was designed in the form of 4 replications randomized block design (RBD) consisting of 4 hybrid corn varieties treatment, namely Bima-20, Bisi-2, NK-22 and Nasa-29. Data collected includes plant growth and yield components. The results showed that maize Bima-20, Bisi-2, NK-22 and Nasa-29 were able to adapt on the ex-coal mined land, although it was not yet in accordance with the potential yield. Productivity of each variety (dry shelled): Bima-20 = 6.8 t ha⁻¹, Bisi-2 = 7.2 t ha⁻¹, and NK-22 = 7.1 t ha⁻¹ and Nasa-29 = 7.9 t ha⁻¹.

1. Introduction
The coal is one of the strategic minerals and has become a huge energy resource (Hidayanto M., 2018). These minerals are hydrocarbon rocks, the formation process (coalification) takes millions of years, starting from the formation that produces peat, lignite, subbituminous, bituminous, and finally with the formation of anthracite [1]. Based on data from the Ministry of Forestry in 2004, East Kalimantan there were 42 holders of a Lease-to-Use Forest Area (IPPKH) permit. The forest area used for exploration is 402,655.98 ha and for production operations 191,343.04 ha [2].

In East Kalimantan, land used for mining business reaches 4.4 million hectares, consisting of 3.1 million hectares for 1,212 mining business permits (IUP) and 1.3 million hectares of land for 33 special IUPs. Mining potential in the province is quite large and accounts for 45.83% of regional income [3]. However, up to now thousands of hectares of ex-coal mined land, both reclaimed and left neglected, have not provided benefits to the community, and even have caused environmental damage.

Coal mining activities are generally carried out by open mining techniques, namely by opening land, peeling top soil, piling top soil, and then mining coal. This technique causes physical, chemical and biological damage to the soil, so it is not suitable for growing plants, due to poor nutrient elements [4]. Ex-coal mined land is marginal land that is poor in nutrients. Nutrients available for plant growth are very low, so to support optimal plant growth it is necessary to supply nutrients from outside [5],[6]. East Kutai Kartanegara Regency is one of the regions that has quite extensive ex-mined land. Therefore, in order to support the development of maize in the Regency, through the Maize Revolution Program, it is necessary to study the adaptation test of several hybrid maize varieties in the
agroecosystem of the ex-coal mined land. The use of adaptive maize varieties is needed to support increased productivity, because not all varieties are able to grow and develop well in various agroecosystems. Each variety will provide optimal results according to the potential yield if planted on suitable land or environment, and specific location technology is needed [7],[8].

2. Methodology
The adaptation test of hybrid maize was carried out in the ex-coal mined area in Teluk Dalam, Tenggarong Seberang District, Kutai Kartanegara Regency, East Kalimantan Province from March to July 2018. The assessment was prepared using a Randomized Block Design (RBD) involving 4 farmers as replications, consists of the treatment of 4 maize hybrid varieties namely Bima-20, Bisi-2, NK-22 and Nasa-29. The technology component is applied with a specific location of Integrated Crops Land Management (ICLM) approach, minimum tillage, planting 2 seeds per hole, planting distance (80 x 20) x 20 cm, applying lime, providing organic and biological fertilizers and chemical fertilizers. Chemical fertilizers used are NPK Phonska 350 kg ha\textsuperscript{-1} and Urea 150 kg ha\textsuperscript{-1} which is done 2 times, 7 days after planting and 21 days after planting. Weed control manually and with selective herbicides, integrated pest and disease control, harvest and post-harvest. Data collected were plant growth and yield components (plant height, cob length, number of rows per cob, the weight of 1000 grains and productivity). Data collected were analyzed by analysis of variance (ANOVA) and tested by DMRT to determine differences between treatments.

3. Results and Discussion
3.1. Soil analysis
The analysis of soil samples before the assessment in Table 1 show that the acidity of ex-coal mined soil pH is low, low of organic matter, the availability of N, P and K nutrients is low. Research results showed that corn in P nutrient deficiency conditions will affect growth and yield [9]. Therefore it is necessary to manage location specific land through the addition of soil amendment the form of agricultural lime, organic and biological fertilizer and liquid organic fertilizer added.

| No. | Criteria          | Result Sample 1 | Result Sample 2 | Unit          | Method                  |
|-----|------------------|-----------------|-----------------|---------------|-------------------------|
| 1   | Moisture content | 9.81            | 11.60           | %             | Gravimetric & Oven (105°C) |
| 2   | pH H\textsubscript{2}O | 5.28            | 4.29            | pH H\textsubscript{2}O |                        |
| 3   | pH KCl          | 4.90            | 3.67            | pH KCl       |                        |
| 4   | Organic matter  |                 |                 | %             | Spektrofotometric       |
|     | C               | 0.89            | 0.92            |               |                         |
|     | N               | 0.01            | 0.01            |               |                         |
| 5   | P & K tot       |                 |                 | mg/100 g     | Extract HClO\textsubscript{4} |
|     | P               | 133.41          | 8.22            |               |                         |
|     | K               | 127.61          | 140.51          |               |                         |
| 6   | Al-\textit{dd}  | 5.02            | 1.15            | cmol\textsuperscript{+} kg\textsuperscript{-1} | Titration               |
| 7   | H-\textit{dd}   | 0               | 0               |               |                         |
| 8   | Macro element   |                 |                 | %             | Extract HClO\textsubscript{4} |
|     | Ca              | 5779.47         | 11080.21        |               |                         |
|     | Mg              | 10914.09        | 26131.23        |               |                         |
|     | K               | 7259.05         |                 |               |                         |
| 9   | Micro element   |                 |                 | ppm           | Extract HClO\textsubscript{4} |
|     | Fe              | 489.69          | 1184.45         |               |                         |
|     | Zn              | 25.21           | 72.16           |               |                         |
| 10  | Texture         |                 |                 | %             | Pipet                   |
|     | Loam            | 68              | 8               |               |                         |
|     | Sand            | 17              | 41              |               |                         |
|     | Clay            | 15              | 51              |               |                         |

Source: Soil Laboratory, BPTP East Kalimantan
3.2. Component of Growth

The performance component of plant height, cob height and biomass weight of the four hybrid maize varieties tested varied. Complete data on the growth components of some hybrid maize in Table 2.

| No | Varieties   | Plant height (cm) | Cob height (cm) | Biomass (t ha\(^{-1}\)) |
|----|-------------|-------------------|-----------------|-------------------------|
| 1  | Bima-20     | 189,15c           | 86,70 c         | 16,55 b                 |
| 2  | Bisi-2      | 216,40 a          | 105,23 a        | 17,60 b                 |
| 3  | NK-22       | 212,35 b          | 104,35 a        | 21,45 a                 |
| 4  | Nasa-29     | 210,10 b          | 100,90 b        | 20,40 a                 |
|    | CV (%)      | 4,13              | 7,87            | 10,65                   |

Note: numbers that follow the same letter are not significantly different according to the Duncan test 0.05%

The data of Table 2 shows that plant height is positively correlated with cob height. This is in accordance with the results [10], that the higher the plant, so will be the higher the location of the cob from the ground surface. The data shows that the height of the cob from the ground surface of Bisi-2 reached 216.40 cm and did not differ from the height of corn NK-22 and Nasa-29. The lowest corn height is Bima 20 which is 189.15 cm. The highest biomass weight was NK-22 maize which was 21.45 t ha\(^{-1}\), but it was not significantly different from Nasa-29 biomass. While the lowest biomass weight is Bima-20 maize which is 16.55 t ha\(^{-1}\).

Plant height is one of the criteria for selecting corn [10]. Besides being controlled by genetic and environmental factors, plant growth and production are also influenced by sunlight and rainfall or water availability. Each plant variety has a different ability to be able to adapt to certain environments. Genetic factors are related to the inheritance of plant traits, while environmental factors are related to environmental conditions where plants grow [11].

3.3. Yield component

The yield potential of a maize variety is determined by four components, namely the number of cobs, number of seeds per cob, number of rows per cob, the weight of 1000 grains. The adaptation test (Table 3) show that the Nasa-29 maize with the higher weights of 1000 seeds, the productivity is also high. While the Bisi-2 maize variety has the lowest 1000 grain weight so that productivity is also low.

The data Table 3 shows that the number of parameters between different varieties and the highest number of row parameters is Nasa-29 variety. From productivity parameters, the lowest Bima-20 variety is 6.8 t ha\(^{-1}\), while the highest productivity is Nasa-29 is 7.9 t ha\(^{-1}\). The productivity is still below the yield potential of each variety. The contributing factors, among others, are that land conditions are not optimal to support the growth and production of corn, so there are still opportunities to increase productivity. According to research [7] show that the constraints of the management of the ex-coal mined land for agricultural development include solid soil, unstable soil structure, bad aeration and drainage, slow water to seep, pH to very acidity, and low fertility. This condition is the main limitation, so for the cultivation of plants required the input of fertilizers, organic fertilizers, and biological fertilizers with relatively large doses. High and low productivity depends on the technology applied and climate suitability on the local land. The better the technology applied with favourable climate conditions, better productivity will be achieved.
Table 3. Performance of hybrid maize yield components on ex-coal mined land

| Varieties | Number of Row | Cob length (cm) | Weight 1000 seeds (g) | Productivity (t ha\(^{-1}\)) | Potential yield (t ha\(^{-1}\)) |
|-----------|---------------|----------------|-----------------------|-----------------------------|--------------------------------|
| Bima-20   | 12,70 c       | 17,20 a        | 345,15 b              | 6,80 c                      | 12,50                          |
| Bisi-2    | 12,00 c       | 16,60 b        | 287,20 c              | 7,20 b                      | 13,00                          |
| NK-22     | 14,00 b       | 16,30 b        | 340,20 ab             | 7,10 b                      | 10,48                          |
| Nasa-29   | 15,00 a       | 16,50 b        | 350,30 a              | 7,90 a                      | 13,50                          |
| CV (%)    | 5,52          | 3,54           | 5,04                  | 6,20                        |                                |

Note: numbers that follow the same letter are not significantly different according to the Duncan test 0.05%

4. Conclusion

1. The land of ex-coal mined is quite extensive in Kutai Kartanegara Regency and has the potential for agricultural development, especially for hybrid maize development.

2. The adaptation test maize hybrid varieties show that hybrid maize can grow well on the ex-coal mined land, with applied of location specific technology, even though the results are not in accordance with the yield potential of the tested varieties. The productivity of hybrid maize based on the results of adaptation tests in the ex-coal mined land ranged from 6.50 to 7.9 t ha\(^{-1}\).

3. The introduction of new varieties of Hybrid Maize is expected to be able to increase the productivity and production of maize in the development area through the application of location specific technology.

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