Growth and productivity of several hybrid maize varieties on alluvial soil of Madura in dry season

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Abstract. Although the productivity is very low, maize cultivation on Madura island still uses the local varieties. Considering this situation a field assessment was carried out in Larangan Slampar Village Tlanakan District Pamekasan Regency from May to August 2017. The study was aimed to determine the performance of several national hybrid maize varieties that especially released by the Indonesian Agency for Agricultural Research and Development (IAARD). The experiment was arranged in a randomized completely block design with three replications. The treatments were five superior varieties of the IAARD namely Bima 9, Bima 14, Bima 16, Bima 20, and HJ 21, and one local variety of Madura as a control. The result showed that new varieties tested especially Bima 9 and Bima 14 gave the best performance and significantly different to local variety in some agronomic parameters namely plant height, width and length of leaves and yield. Almost of all agronomic parameters had a positive correlation to the yield. The yield was increased up to 483.87% and the benefit up to 555.67% than local variety. Based on this research and by the choosing of local farmers, both varieties were recommended as a specific location varieties in dry season planting time.

1. Introduction
Maize productivity in East Java province is low compared to other provinces in Indonesia. This is related to the low productivity in several districts especially Madura Island, which only ranges from 1.70 (Sampang Regency) to 2.84 tons/ha (Pamekasan Regency), although the areas of the harvest are the highest [1]. The low yield is closely related to traditional cultivation technology, especially the use of local varieties, and farmers' understanding of PTT and its application in the field are still low. Previous study showed that almost 88% of farmer in Madura was planted local maize variety to fulfill their family's need. Their considerations for using local varieties were the availability of seeds, lower farming costs, longer shelf life, lower costs for managing after harvest and higher selling prices than hybrid varieties. [2].

During this time the maize cultivation technology component is applied partially, especially on low productivity land, so it does not have a real impact on increasing production. Integrating various technology components that mutually supporting or synergistic is expected to increase the productivity and efficiency of the maize production system. Through long-term research, the Indonesian Agency for Agricultural Research dan Development (IAARD) has produced various components of maize technology. The application of these technology components with the Integrated Crop Management (ICM) approach was able to increase farming productivity and efficiency, thus leading to increased incomes. One component of technology that plays a role in increasing productivity is the use of
superior varieties as basic technology [3, 4]. Maximum yields can be achieved by plants if superior cultivars receive a response to the optimum combination of water, fertilizer and other cultivation practices. Therefore the use of superior varieties must be balanced with other cultivation practices to get maximum results. [5].

Various varieties of superior maize both certified hybrids and composites that have been traded freely and have been used by maize farmers. Unfortunately, the seeds are generally produced by foreign private companies, although seed propagation is carried out in Indonesia. There are several superior varieties, both hybrids and composites resulted by domestic breeders, especially from the Cereals Research Center – Indonesian Agency Agricultural Research and Development which has been released by the Ministry of Agriculture (IAARD), but the adoption rate is still far below the introduced varieties of multi national company. In connection with this condition, one of the efforts to increase the adoption of these varieties is the making of demonstration plots or display of new improved varieties in various locations, especially in areas where the use of hybrid varieties is not yet popular.

Each variety has a different level of adaptation to the influence of the growing environment, both on the type and content of soil nutrients, water availability and weather conditions. Adaptive varieties will provide a positive response that is shown by the growth and appearance of the best phenotypic plants with optimum productivity. To obtain the most adaptive high yielding varieties in a certain environmental condition, a study is needed to see the response of the various varieties in the location.

The purpose of the study was to determine the growth and productivity performance of several varieties of domestic hybrid maize especially from IAARD in Madura dry land, as well as functioning as a demonstration plot for surrounding farmers.

2. Materials and Methods
The assessment has been carried out in the dry land of Larangan Slampar village, Tlanakan Subdistrict, Pamekasan Regency from May to August 2017. The study used a randomized block design with 4 replications. The treatments were 5 superior varieties produced by the Cereals Research Institute Indonesian Agency Agriculture Research and Development of the Ministry of Agriculture, namely Bima 9, Bima 14, Bima 16, Bima 20 and HJ 21 and 1 local Madura variety as control. Cultivation technology applied to the five varieties was carried out with an integrated crop management approach, while the control with existing technology.

The soil was processed once with a hand tractor and crushed with a hoe. Especially for these superior varieties, 1 seed per planting hole was planted with a spacing of 70 cm x 20 cm and was given organic fertilizer as much as 1 ton/ha to cover the hole. The fertilizer dose was based on the results of the analysis with the Upland Soil Test Kit (USTK) and Leaf Color Chat (LCC) with a quantity of 300 kg urea and 250 kg Ponska NPK. Application of fertilizer was carried out twice, first at the age of 2 weeks after planting (MST) as much as 1/3 dose, and secondly at the age of 5 weeks at 2/3 doses. Plant maintenance such as weed control was done according to crop conditions. Watering plants until the age of 2 MST by leaking in the planting hole. Subsequent irrigation by watering with a hose. The parameters observed include plant growth and yield, and farming analyses.

The data obtained were tabulated and analyzed for variance. If there were significant differences, proceed with the DMRT test at the 0.05 level. Correlation between some agronomic parameters was also estimated. A farming analysis was conducted to find out the financial benefit of using these new varieties.

3. Result and discussion
3.1. Environmental condition of the field
The land used for the experiment classified as alluvial soil with a clay texture. Based on the Upland Soil Test Kit showed that the soil has a low P, K, and C-organic nutrient content with a neutral pH. Another report showed that the soil in Tlanakan sub-district was very poor of nutrient content with N
content of 0.01%, P205 1.29 mg kg\(^{-1}\), K 0.16 m /100 g, C-organic 0.46 and pH 6.2 [6]. The assessment was located in the lowland with a dry climate and a rainy season only from November to April. During the experiment did not rain from the beginning of planting until the harvest activities. Climatic conditions throughout the study with a daily temperature range between 28-32 °C with a humidity of 65-70%. To fulfill water needs, the plants were irrigated with a hose with limited water availability.

3.2. Analysis of variance for parameters observed
Anova for the growth and yield parameters was shown in Table 1. All parameters observed did not influenced significantly (P > .05) by the blocking effect. In order to increase the Error degree of freedom (df), the blocking effect was omitted. All agronomic characters (parameters) were significantly affected by the treatment.

| Parameter                          | Source of Variation | Degree of freedom (Df) | Sum of squares | Means squares | F       | Sig.  |
|------------------------------------|---------------------|------------------------|----------------|---------------|---------|-------|
| Plant height (cm)                  | Between groups      | 5                      | 18193.21813    | 3638.644      | 24.930  | 1.67E-07 |
|                                   | Within groups       | 18                     | 2627.1474      | 145.9526      |         |       |
|                                   | Total               | 23                     | 20820.36553    | 905.2333      |         |       |
| Stalk diameter (cm)                | Between groups      | 5                      | 10.86033333    | 2.172067      | 14.934  | 7.28E-06 |
|                                   | Within groups       | 18                     | 2.618          | 0.145444      |         |       |
|                                   | Total               | 23                     | 13.47833333    | 0.586014      |         |       |
| Leaf length (cm)                   | Between groups      | 5                      | 6574.551533    | 1314.91       | 47.7307 | 9.18E-10 |
|                                   | Within groups       | 18                     | 495.8726       | 27.54848      |         |       |
|                                   | Total               | 23                     | 7070.424133    | 307.4097      |         |       |
| Leaf width (cm)                    | Between groups      | 5                      | 92.39233333    | 18.47847      | 18.4262 | 1.62E-06 |
|                                   | Within groups       | 18                     | 18.051         | 1.002833      |         |       |
|                                   | Total               | 23                     | 110.4433333    | 4.801884      |         |       |
| Downy mildew diseases (%)          | Between groups      | 5                      | 169.2595333    | 33.85191      | 6.944266| 0.000897 |
|                                   | Within groups       | 18                     | 87.7464        | 4.8748        |         |       |
|                                   | Total               | 23                     | 257.0059333    | 11.17417      |         |       |
| Cob length (cm)                    | Between groups      | 5                      | 203.7477333    | 40.74955      | 6.142273| 0.001729 |
|                                   | Within groups       | 18                     | 119.417        | 6.634278      |         |       |
|                                   | Total               | 23                     | 323.1647333    | 14.05064      |         |       |
| Cob diameter (cm)                  | Between groups      | 5                      | 20.41          | 4.08188       | 6.799733| 0.001006 |
|                                   | Within groups       | 18                     | 10.81          | 0.6003        |         |       |
|                                   | Total               | 23                     | 31.21          | 1.357165      |         |       |
| Cob weight (g)                     | Between groups      | 5                      | 141928         | 28385.7       | 63.02712| 8.99E-11 |
|                                   | Within groups       | 18                     | 8106.71        | 450.3728      |         |       |
|                                   | Total               | 23                     | 150035         | 6523.27       |         |       |
| Kernel weight/cob (g)              | Between groups      | 5                      | 83352          | 16670.37      | 26.15184| 1.15E-07 |
|                                   | Within groups       | 18                     | 11474          | 637.4454      |         |       |
|                                   | Total               | 23                     | 94826          | 4122.864      |         |       |
| Net kernel weight                  | Between groups      | 5                      | 0.024363556    | 0.004873      | 0.632721| 0.677378 |
|                                   | Within groups       | 18                     | 0.13862163     | 0.007701      |         |       |

Table 1. Analyses of variances for maize agronomic characters
### 3.3. Plant Growth Performance

The result showed that Bima 14 and HJ 21 varieties have the highest plant posture, which was significantly different from Bima 20 and local Madura (Table 2). Observation of stem diameter showed that Bima 9 and Bima 14 and HJ 21 varieties have the largest stem sizes and significantly different from Bima 20 and local Madura varieties. This fact indicated that each variety had a different growth response to the environmental conditions of the experimental site. Another researcher cited that high plants can receive full sunlight intensity, therefore the photosynthesis process will run optimally which can increase the supply of nutrients to the leaves, stems, and seeds that trigger plant growth and biomass [7].

Leaf observation showed that there were significant differences between varieties both the length and width of the leaf, especially with local varieties that genetically have a small plant postures (Table 2).

| Treatment (Varieties) | Plant height (cm) | Stalk diameter (cm) | Leaf length (cm) | Leaf width (cm) | Downy mildew diseases (%) |
|-----------------------|-------------------|---------------------|------------------|-----------------|---------------------------|
| Bima 9                | 167,32 ab         | 3,13 a              | 89,72 a          | 10,33 a         | 10,31 b                   |
| Bima 14               | 175,72 a          | 3,04 a              | 86,02 a          | 9,31 a          | 9,43 b                    |
| Bima 16               | 162,54 ab         | 2,52 ab             | 78,91 b          | 9,72 a          | 10,65 b                   |
| Bima 20               | 153,53 b          | 2,17 b              | 87,85 a          | 8,79 a          | 10,32 b                   |
| HJ 21                 | 178,71 a          | 3,03 a              | 91,48 a          | 9,25 a          | 12,25 b                   |
| Local Madura          | 97.12 c           | 1,22 c              | 43.71 c          | 4,37 b          | 17,35 a                   |
| CV                    | 7.75              | 15.14               | 6.61             | 11.61           | 18.84                     |
| SEM                   | 6.04              | 0.19                | 2.62             | 0.50            | 1.1                       |

Observation of diseases attacking showed that only downy mildew was found in low intensity. The highest intensity was obtained in HJ 21 variety which reached 12.25 (Table 2). Other study showed that HJ 21 Agritan, Bima-14 Batara, and Bisi-19 which previously had high resistance, recently had a low level of sustainability or became vulnerable to fungal infections of P. maydis with intensity up to 62-77.25 % [8].

### 3.4. Harvest Yield

The variety that has the longest cob was Bima16 with an average size of 19.60 cm and was significantly different from Bima 9 and local Madura (Table 3). The diameter of the cob showed that the largest cob was produced by Bima 20 and HJ 21 varieties and significantly different from local varieties. The cobs observation showed that the Bima 9 and Bima 14 varieties had the highest weights of 284.07 and 2587.30, which were significantly different from Bima 16, Bima 20 and local Madura. Previous study also indicated that that different genotypes will give a different response even in the same environment [9].

| Treatment (Varieties) | Plant height (cm) | Stalk diameter (cm) | Leaf length (cm) | Leaf width (cm) | Downy mildew diseases (%) |
|-----------------------|-------------------|---------------------|------------------|-----------------|---------------------------|
| Bima 9                | 167,32 ab         | 3,13 a              | 89,72 a          | 10,33 a         | 10,31 b                   |
| Bima 14               | 175,72 a          | 3,04 a              | 86,02 a          | 9,31 a          | 9,43 b                    |
| Bima 16               | 162,54 ab         | 2,52 ab             | 78,91 b          | 9,72 a          | 10,65 b                   |
| Bima 20               | 153,53 b          | 2,17 b              | 87,85 a          | 8,79 a          | 10,32 b                   |
| HJ 21                 | 178,71 a          | 3,03 a              | 91,48 a          | 9,25 a          | 12,25 b                   |
| Local Madura          | 97.12 c           | 1,22 c              | 43.71 c          | 4,37 b          | 17,35 a                   |
| CV                    | 7.75              | 15.14               | 6.61             | 11.61           | 18.84                     |
| SEM                   | 6.04              | 0.19                | 2.62             | 0.50            | 1.1                       |
Table 3. Performance of harvest yield component and yield of some new variety of maize in alluvial soil at Larangan Slampar village Tlanakan district Pamekasan regency

| Treatments (Varieties)       | Cob length (cm) | Cob diameter (cm) | Cob weight (g) | Kernel weight/ cob (g) | Net kernel weight | 100 kernel weight (g) | Yield (ton) | Increased yield of new varieties to existing (%) |
|------------------------------|-----------------|-------------------|----------------|------------------------|------------------|-----------------------|-------------|-----------------------------------------------|
| Bima 9                       | 17.96 a         | 4.63 a            | 257.80 a       | 194.57 a               | 0.75 a           | 46.17 a               | 5.31 a      | 470.97                                       |
| Bima 14                      | 19.22 a         | 4.67 a            | 284.07 a       | 223.33 a               | 0.79 a           | 46.24 a               | 5.43 a      | 483.87                                       |
| Bima 16                      | 19.60 a         | 4.77 a            | 212.27 b       | 168.13 b               | 0.79 a           | 43.15 a               | 4.01 b      | 331.18                                       |
| Bima 20                      | 19.17 a         | 4.05 a            | 198.33 b       | 166.76 b               | 0.84 a           | 40.33 a               | 4.15 b      | 346.24                                       |
| HJ 21                        | 18.22 a         | 5.18 a            | 223.80 b       | 167.44 b               | 0.75 a           | 42.43 a               | 4.26 b      | 358.06                                       |
| Existing (Lokal Madura)      | 11.17 b         | 2.35 b            | 43.67 c        | 35.63 c                | 0.82 a           | 16.54 b               | 0.93 c      |                                               |

CV 14.67 18.12 10.64 15.64 11.93 10.43 4.98
SEM 1.28 0.37 10.41 12.62 4.39 2.05 0.10

Observation of kernel weight per cob showed that the highest weight was obtained in Bima 14 and Bima 9 varieties and significantly different from local Madura varieties. The weight per 100 kernel was not significantly different from other varieties, except to local Madura varieties (Table 3).

Net kernel weight which is a comparison of the weight of shelled yield compared to ear weight of the cob before threshed. There was not significantly different in net kernel weight variable between varieties tested. The highest net kernel weight was resulted by Bima 16 and local varieties. Although the size of local Madura maize cobs was very small, it can produce seeds with maximum weight.

The yield observation showed that Bima 14 and Bima 9 varieties produce the highest yielding 5.43 tons and 5.31 tons ha\(^{-1}\) respectively, and significantly different from other Bima varieties, and very significantly different to local Madura variety which only produces 0.93 tons ha\(^{-1}\) (Table 3). If observed further that these varieties can increase the productivity up to 483.87% compared to local variety. This result indicates that the Bima 14 and Bima 9 varieties were the most adaptive and tolerant varieties to dry season and drought condition. Despite the availability of the water was limited, these plants still harvested. The performance of a character will optimal if the plant was located in the appropriate environment. Vice versa, the performance will not be optimal if an environment was unsuitable. Performance of a character with high heritability has a little environment influence, thus its appearance will be relatively fixed. However, characters of low reliability have a big environmental influence, thus its performance easy to change [7].

Table 4. The correlation coefficients of grain yield and agronomic parameters

| Parameters                        | Plant height (cm) | Stalk diameter (cm) | Leaf length (cm) | Leaf width (cm) | Downy mildew diseases (%) | Cob length (cm) | Cob diameter (cm) | Cob weight (g) | Kernel weight/ cob (g) | Net kernel weight | 100 kernel weight (g) | Yield (ton/ha) |
|-----------------------------------|-------------------|---------------------|------------------|-----------------|---------------------------|----------------|-------------------|----------------|------------------------|------------------|---------------------|----------------|
| Plant height (cm)                 | 1.0000            |                     |                  |                 |                           |                |                   |                 |                        |                  |                     |                |
| Stalk diameter (cm)               | 0.7785            | 1.0000              |                  |                 |                           |                |                   |                 |                        |                  |                     |                |
| Leaf length (cm)                  | 0.8387            | 0.7340              | 1.0000           |                 |                           |                |                   |                 |                        |                  |                     |                |
| Leaf width (cm)                   | 0.7941            | 0.6985              | 0.8100           | 1.0000          |                           |                |                   |                 |                        |                  |                     |                |
| Downy mildew diseases (%)         | -0.6413           | -0.6589             | -0.6875          | -0.7900         | 1.0000                    |                |                   |                 |                        |                  |                     |                |
| Cob length (cm)                   | 0.7217            | 0.6382              | 0.7046           | 0.5802          | -0.4614                   | 1.0000         |                   |                 |                        |                  |                     |                |
| Cob diameter (cm)                 | 0.8173            | 0.5942              | 0.7107           | 0.6218          | -0.5273                   | 0.5742         | 1.0000            |                 |                        |                  |                     |                |
| Cob weight (g)                    | 0.8586            | 0.8392              | 0.8642           | 0.8202          | -0.7181                   | 0.6947         | 0.6640            | 1.0000          |                        |                  |                     |                |
| Kernel weight/ cob (g)            | 0.7060            | 0.8055              | 0.8331           | 0.8643          | -0.8404                   | 0.6518         | 0.5503            | 0.9518          | 1.0000                 |                  |                     |                |
| Net kernel weight                 | -0.2117           | -0.1463             | -0.1803          | 0.0545          | -0.3342                   | -0.1910        | -0.3799           | -0.2251         | 0.0780                 | 1.0000           |                     |                |
| 100 kernel weight (g)             | 0.8108            | 0.7927              | 0.8338           | 0.8427          | -0.6919                   | 0.7342         | 0.7163            | 0.9401          | 0.8830                 | 0.2648           | 1.0000              |                |
| Yield (ton/ha)                    | 0.8970            | 0.8179              | 0.8912           | 0.8338          | -0.7436                   | 0.7176         | 0.7427            | 0.9591          | 0.9021                 | -0.2443          | 0.9107              |                |
Correlation analyses between agronomic parameters showed that almost of parameters has correlation to the yield, except net kernel weight (Table 4). The plant height had a positive correlation to yield ($R^2= 0.8045$). The cob weight also had a positive correlation the yield ($R^2= 0.9501$). Kernel weight/cob and 100 kernel weight also had a positive correlation to the yield ($R^2 = 0.8138$ and $0.8293$). Similar finding have been reported in previous study that grain yield was positively and strongly correlated with plant height, ear height and field weight and with high genotypic and phenotypic correlation coefficients [10]. Another study also showed that kernel yield had a positive and significant correlation with plant height, 300-kernel weight, flag leaf height, kernel no/row and total kernel no/ear [11].

3.5. Farming Analysis
The farming analysis showed that the highest profits were obtained from Bima 14 and Bima 9 varieties Rp. 11,454,500 and Rp. 10,976,500 respectively, while the local variety only reached Rp. 1,747,000. B/C ratio of these varieties was 1.12 and 1.07, while the local variety was only 0.60. Furtherly, these superior varieties also can increase the benefit up to Rp 9,707,500 or 555.67 % compared to existing varieties. Based on this fact, both varieties were feasible to disseminate and adopted by local farmers. This result was consistent with the opinion that changing the technology of varieties to superior varieties is feasible to be introduced if it produces additional benefits for maize farmers [12].
Table 5. Farming analysis of some new varieties cultivation in alluvial soil at Larangan Slampar village Tlanakan district Pamekasan regency

| Description | Local variety | Bima 9 | Bima 14 | Bima 16 | Bima 20 | HJ 21 |
|-------------|---------------|-------|---------|---------|---------|-------|
| A. Total cost | 2,903,000 | 10,263,500 | 10,265,500 | 10,133,500 | 10,147,500 | 10,158,500 |
| B. Revenue | 4,650,000 | 21,240,000 | 21,720,000 | 16,040,000 | 16,600,000 | 17,040,000 |
| C. Benefit | 1,747,000 | 10,976,500 | 11,454,500 | 5,906,500 | 6,452,500 | 6,881,500 |
| D. R/C ratio | 1.60 | 2.07 | 2.12 | 1.58 | 1.64 | 1.68 |
| E. B/C ratio | 0.60 | 1.07 | 1.12 | 0.58 | 0.64 | 0.68 |
| F. Δ Benefit of new varieties to local varieties | - | 9,229,500 | 9,707,500 | 4,159,500 | 4,705,500 | 5,134,500 |

4. Conclusion

Based on values of agronomic parameters, new introduced varieties performance was better than existing variety. Almost of all parameters had a positive correlation to the harvest yield. Bima 9 and Bima 14 produce the highest yield up to 483.87% compared to local variety. This fact indicated that both varieties has the highest adaptability to dry season climate and limited irrigation environments. Both varieties also can increase the farming benefit with a B/C ratio 1.07 and 1.12 and its profitable up to Rp 9,707,500 or 555.67% than local varieties. So that these varieties can be considered for site-specific competen technology of IPM especially in the dry season planting time.

References

[1] BPS_Indonesia Statistic 2016 Hasvested area, production and productivity of maize in Madura.
[2] Sugiarti T and Hayati M 2009 Persepsi petani Madura dalam menolak komoditas jagung varietas baru. Embryo 6 1 : 35–46.
[3] Zubachtirodin, Saenong S, Pabbage M S, Azrai M, Setyorini D, Kartuamatja S and Kasim F 2016 Pedoman Umum PTT Jagung. Badan Penelitian dan Pengembangan Pertanian. Kementerian Pertanian. Jakarta. 20p.
[4] Suyamto, Zubachtirodin, Pabbage M S, Saenong S and Widiarta I N 2008 Panduan Pelaksanaan Sekolah Lapang Pengelolaan Tanaman Terpadu (SL-PTT) Jagung. Departemen Pertanian 43p.
[5] Wawointana A C, J Pongoh, W Tilaar. Pengaruh varietas dan jenis pengolahan tanah terhadap pertumbuhan dan hasil tanaman jagung (Zea mayz, L.). J LPPM Bidang Sains dan Teknologi 4 2 79–93.
[6] Cahyani N K M D, Nurhatika S and Muhibuddin A 2014 Eksplosasi Mikoriza Vesikular Arbuskular (MVA) Indigenous pada Tanah Aluvial di Kabupaten Pamekasan Madura. J. Sain and Seni POMITS 3 1 E 22-25 http://dx.doi.org/10.12962/j23373520.v3i1.5525
[7] Soehendi R dan Syahri B 2013 Potensi Pengembangan Jagung di Sumatera Selatan J. Lahan Suboptimal 2 1 81-92.
[8] Pakki S 2017 Kelestarian Ketahanan Varietas Unggul Jagung terhadap Penyakit Bulai Peronosclerospora maydis Penelitian Pertanian Tanaman Pangan 1 1 37 – 44.
[9] Haryati Y dan A Sinaga 2016 Pengujian adaptasi beberapa varietas jagung hibrida spesifik lokasi di Kabupaten Majalengka. J Agrotek Lestari 2 1 5 –58.
[10] Nzuvel F, Githiri S, Mukunya D M and Gethi J 2014 Genetic Variability and Correlation Studies of Grain Yield and Related Agronomic Traits in Maize J Agricultural Sci 6 9 166-176 http://dx.doi.org/10.5539/jas.v6n9p166
[11] Moradi H., Akbari G A, Khorasani S K and Ramshini H A 2012 Evaluation of drought tolerance in corn (Zea mays L.) new hybrids with using stress tolerance indices European J. Sustainable Development 1 3 543-560.
[12] Fadwiwati A Y 2013 *Pengaruh Penggunaan Varietas Unggul Terhadap Efisiensi, Pendapatan dan Distribusi Pendapatan Petani Jagung di Provinsi Gorontalo*. Disertasi. Sekolah Pasca Sarjana Institut Pertanian Bogor. 115p. https://repository.ipb.ac.id/jspui/bitstream/123456789/66797/1/2013ayf.pdf.