

Case Study of Maize Planting On Marginal Dry Land in The Rainy Season in Lampung

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Abstract— Nationally Lampung Province is the third largest maize producer after East Java and Central Java. Prime land for planting maize in this region is marginal dry land. Productivity of dry land in the region has declined due to intensive use for growing food crops, especially maize and cassava. Objective of the study was to study the prospects of further development of maize on marginal dry land of acid soil in Lampung province. Reduced productivity of dry land caused by land degradation, one due to decreased water holding capacity. It can be argued that because the results of the soil analysis showed the soil of these areas have low organic matter content and soil texture while also rich fraction of sand (sandy loam). The condition was exacerbated by the daily rainfall distribution is uneven due to climate change, which resulted in plants often experience water stress. Results of the study proved, namely maize varieties Bima 2 and Bima 3 on dry land in East Lampung during the rainy season 2011/2012 was relatively unsuccessful due to the production of maize <50% optimal production.

Keywords— Maize; Marginal Dry Land; Rainy Season; Lampung.

I. INTRODUCTION

Nationally Lampung province is the third largest producer of maize after East Java and Central Java. In 2013 maize production target were 1,762,986 tonnes of dry grains from 389,562 ha planting area with an average productivity of 47.64 qu / ha [6]. BPD HIPMI Lampung [4] told that the potential land for the maize planting development in Lampung Province reached 500 thousand hectares.

Regional largest maize grower in Lampung Province is the East Lampung regency. According to the regional government of East Lampung [13] dry land potential for the development of maize and other food crops in the region are 141.474 ha. In 2011 maize harvesting land in this area reached 132,339 ha with an average productivity of 4.84 ton of dry grains / ha.

The results of agro-ecological characteristics identification showed that the limiting factors of plant growth in some districts of food crop production centers in East Lampung regency were some soil physical properties such as effective soil depth, coarse material, texture, low organic matter content and also low soil nutrient availability index in an effort to optimize the productivity of maize [9]. From the condition of the physical properties of soil identified, allegedly soil in this area has low water holding

capacity, so the plants will often experience water stress when it rained late / uneven.

Maize is one of the main commodities developed by farmers in East Lampung marginal dry land. Maize growth is more resistant to water stress at the early phase of growth. Lack of water during the maize growth will decrease yield significantly [11].

To increase the productivity of maize in marginal dry land, the various factors that affect plant growth must be learned before using technological innovation to recommend the solutions of dry land productivity problems. One of the activities that can be done is to study the variability of plant and connect it to the condition of the environmental factors that affect the growth and production of crops such as climate and soil.

Objective of the study was to study the prospects of further development of maize on marginal dry land of acid soil in Lampung province.

II. MATERIALS AND METHODS

Dry land used for the study was farmers' land of 2.5 ha area. The slope of the dry land was about 3-8%. The soil of the land was classified as Hapludults [5] and located under the climate type C2 [12]. In this area, on average, the rainy season begins in mid-October until June. While the dry

months for 2-3 months in a year usually occurs in July, August and September. This case study started from October 2011 to March 2012.

Maize that planted was varieties Bima 2, and Bima 3. Each variety were planted on plots measuring 40 mx 40 m. Third varieties grown are treated the same, either way of tillage, planting or fertilizing dose. Ground cleared of weeds with herbicides, then processed with hand tractor, then raked and made beds of 10 x 20 m cross slope. Maize planted in drill (one seed in one planting hole) with a spacing of 70 x 20 cm. Plants fertilized with organic (manure) of 2,500 kg / ha, 300 kg / ha urea and 200 kg / ha compound fertilizer (Phonska). Observation of the performance of growth and crop production for each variety were done on three plots of land in the upper and 3 plots of land at the bottom.

Data/parameter were observed daily rainfall, physico-chemical properties of the soil, and growth and production of maize. Soil samples for analysis of physico-chemical properties of the soil be taken as a composite, on the slopes of the upper, middle and lower. Water balance is calculated by using the program Cropwat 8.0 [7]. Data were analyzed descriptively.

III. RESULTS AND DISCUSSION

A. Soil Characteristics

Topsoil texture (0-20 cm) on the location of the study on average is categorized as sandy clay loam texture. This texture can be categorized as a rather smooth texture. Topsoil rich enough of sand fraction will cause water easily lost from the topsoil. According Saskatchewan [15], water holding capacity of sandy clay loam soil is only about 12%, compared to clay-textured soils that have a water holding capacity to 18%. In general, the chemical characteristics of the soil were already in marginal level. Soil organic carbon content, total N, available P and exchangeable cations and cation exchange capacity (CEC) were in the category of low to very low (Table 1). These indicate that the index of nutrient availability was one of the factors limiting the growth of maize in the marginal dry land.

B. Daily Rainfall (mm) and Water Balance During Maize Planting

Total daily rainfall in October (108.7 mm) indicates that in October was not a dry month for rainfall >100 mm [12]. However, the monthly total rainfall could not be categorized as a wet month (rainfall >200 mm) [12]. Similarly, in the next month (November) apparently rainfall <100 mm meaning is still relatively dry months. Nonetheless total rainfall during the 97 days of planting maize was 564 mm (Table 2) were considered sufficient for the growth of maize. According to FAO [8] the amount of water requirement of maize per cropping season was between 500-800 mm.

Further analysis of the properties of the rain associated with the distribution of daily rainfall, the precipitation tends to fall looks uneven. In the 1st and 2nd week of November for 12 consecutive days almost no rain (Fig 1). The same thing also occurred at week 2 of December. Total rainfall from planting of maize to vegetative growth phase (239 mm) (Table 2) was considered sufficient. But the days without rain (29 days) more than rainy days (26 days)(Table 2). The

consecutive days without rain for 10 days or more, coupled with low soil water holding capacity will certainly interfere with the growth of maize.

TABLE I
PHYSICO-CHEMICAL CHARACTERISTICS OF THE TOPSOIL (0-20 CM) OF THE STUDIED AREA

Parameter	Soil Characteristics			Avera ge
	I	II	III	
- Sand (%)	61.6	59.6	45.6	55.6
- Loam (%)	19.6	12.8	14.8	15.7
- Clay (%)	18.8	27.6	39.6	28.7
pH (H ₂ O)	4.62	4.71	4.68	4.67
C-organic (%)	1.19	1.12	1.23	1.18
N total (%)	0.12	0.11	0.11	0.11
C/N	9.92	10.18	11.18	10.43
P available (Bray 1) (ppm P ₂ O ₅)	5.24	19.03	10.18	11.48
P potential (mg P ₂ O ₅ /100 g)	13.57	20.50	14.68	16.25
K potential (mg K ₂ O/100 g)	16.28	13.63	14.62	14.84
K-dd (cmol/Kg)	0.29	0.17	0.25	0.24
Na-dd (cmol/Kg)	0.90	0.90	0.76	0.85
Ca-dd (cmol/Kg)	1.26	3.17	0.86	1.76
Mg-dd (cmol/Kg)	0.72	0.83	0.79	0.78
KTK (cmol/Kg)	8.53	8.80	8.53	8.62
KB (%)	37.16	57.61	31.18	41.98
Al-dd (cmol/Kg)	0.50	0.20	0.40	0.37

Analysis of rainfall data were further used to determine the condition of 10 daily rainfall and effective rainfall (Pe). Calculations done manually, using the formula of Smith (1988), namely for monthly rainfall <70 mm, Pe = 0.6 Ptotal - 10, and for rainfall > 70 mm, Pe = 0.8 Ptotal - 25, while, evapotranspiration (ET) of maize was calculated with the Cropwat program. The results of the analysis (Fig 2), indicating that maize planted in late October, facing water stress in the first week of November because there was no rain for 12 consecutive days at that time (Fig 1). Similarly, at week 4 in December, the plants aged 30-40 HST (vegetative growth period) were also experiencing water stress. According to Steduto et al. [17] 50% water shortage in vegetative growth phase, will reduce maize yields 40-50%.

Furthermore the availability of water at the time of maize planting was analyzed with the Cropwat program. Water needs of maize evapotranspiration (ETc) for each phase of growth predicted by the crop coefficient (Kc) that ETc = Kc x ET0 [1]. In addition to monthly rainfall data and the properties of elements of climate such as temperature, humidity, wind, and sun radiation, to calculate ET0 was used the coefficient values presented by Allen et al. [1] as the basis of calculation (Table 3).

However, when the analysis of water availability predictions for maize growth was accomplished using the Cropwat, in which data entry into the program is based on the amount of monthly rainfall, the need for maize watering during the study only recommended at the time of planting as many as 1.9 mm / dec (Table 4).

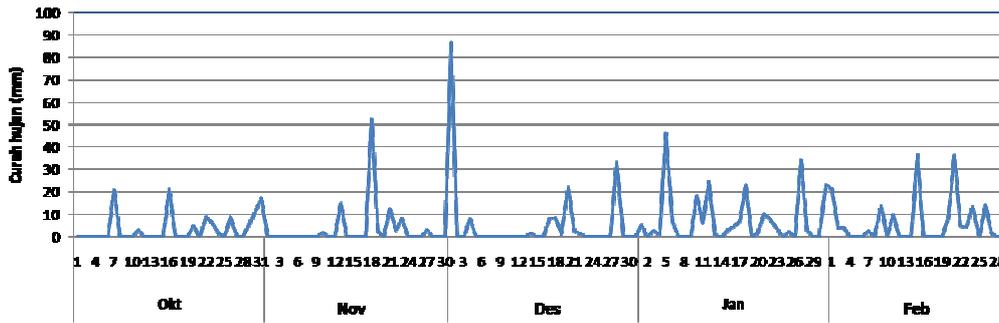


Fig 1. Daily rainfall during the study in East Lampung

TABLE II
NATURE OF RAINFALL DURING THE PLANTING MAIZE IN THE RAINY SEASON 2011-2012 IN EAST LAMPUNG

Nature of Rainfall	Maize Growth		Total
	Phase before flowering	Phase flowering and fruit ripe	
Day Observation	45	52	97
Rainy days	26	26	52
Days without rain	29	26	55
Total rainfall (mm)	239.2	324.7	564

the study period, was only the range of 295 mm. While using the program Cropwat of which the calculation of effective precipitation based on monthly rainfall data, obtained effective rainfall for maize growth in a number of 401 mm (Table 4). As informed FAO [8] water demand of maize is between 500-800 mm per cropping season.

TABLE IV
RESULTS OF ANALYSIS OF WATER AVAILABILITY PREDICTIONS FOR MAIZE DURING THE STUDY BY CROPWAT PROGRAM

Month	Decade	Stage	Kc	ETc mm/day	ETc mm/dec	Eff rain mm/dec	Irr. mm/dec
Nov	1	Init	0.45	1.93	1.9	2.6	1.9
Nov	2	Init	0.45	1.88	18.8	24.7	0
Nov	3	Deve	0.45	1.83	18.3	30.4	0
Dec	1	Deve	0.55	2.17	21.7	37.6	0
Dec	2	Deve	0.71	2.71	27.1	42.9	0
Dec	3	Deve	0.88	3.37	37.1	44.9	0
Jan	1	Mid	1.04	4.02	40.2	47.9	0
Jan	2	Mid	1.08	4.23	42.3	50.9	0
Jan	3	Late	1.07	4.17	45.9	48	0
Feb	1	Late	0.83	3.23	32.3	43	0
Feb	2	Late	0.57	2.23	15.6	28	0
					301	401	1.9

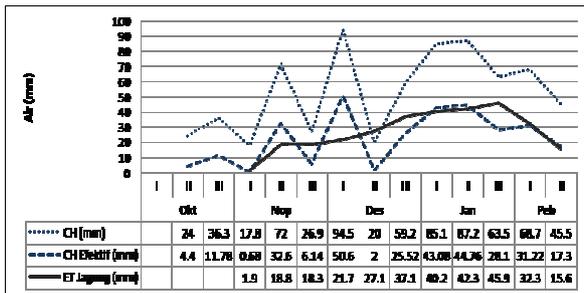


Fig 2. Rainfall, effective rainfall (Smith, 1988) and maize evapotranspiration (ETc) during the study in rainy season in East Lampung.

TABLE III
SOME PROPERTIES OF THE PLANT AND THE COEFFICIENT VALUES RECOMMENDED BY ALLEN ET AL. [1] FOR CALCULATION OF THE IRRIGATION WATER REQUIREMENT OF MAIZE

Growth Stage	Initial	Development	Mid-season	Late season	Total
Kc. value (coeff.)	0.45	>>	1.20	>>	0.50
Length (days)	20	30	30	20	100
Rooting depth (cm)	30	>>	>>	100	-
Critical depletion (fract)	0.50	>>	0.50	0.80	-
Yield response (coeff.)	0.40	0.40	1.30	0.50	1.25

C. Maize Growth and Yield

Calculation result manually using formulas Smith [16], to get the amount of effective rainfall for growing maize during

Two varieties of maize, namely Bima 2 and Bima 3, although it is able to produce, but the results obtained are below the optimal production (Table 5). From the observations seen that the growth of these varieties of maize are not optimal, although given organic fertilizer and inorganic sufficiently. Marginal dry land and less available water had hampered the vegetative and generative growth of Bima 2 and Bima 3. This was indicated by both plant height is only about 153-158 cm and dry seed production of shelled 3750-4789 kg / ha (Table 5). According to the Cereal Crops Research Institute [3], under optimal environmental conditions, high maize of varieties Bima 2 and Bima 3 can reach 200 cm and two maize varieties capable of producing dry shelled beans between 8270 kg / ha to 8500 kg / ha. Lack

of water immediately after planting, and at the phase of vegetative growth, can exacerbate the growth and yield and quality of maize significantly [10, 14, 11].

TABLE V
GROWTH AND PRODUCTION OF MAIZE VARIETIES BIMA 2 AND BIMA 3, PLANTED DURING THE WET SEASON IN MARGINAL DRY LAND IN EAST LAMPUNG

Variety	height (cm)	Leaf Width (cm)	Yield (Kg/ha)
Bima 2	153.3	15.3	3750
Bima 3	158.3	15.2	4789

IV. CONCLUSIONS

Quality of dry land in Lampung Province especially in East Lampung has declined due to intensive use for growing of food crops, especially maize and cassava. One of the allegedly elements of poor quality land is water holding capacity. It can be argued that because in addition the soil has low organic matter, its texture is rich in sand. Results of the study proved that the planting of maize varieties Bima 2 and Bima 3 in the rainy season 2011/2012 in East Lampung, was relatively unsuccessful due to the production of maize <50% optimal production. The main factor causing poor growth and production was water stress. Maize experiencing water stress was as a result of no rain for 10 to 12 days consecutively. It was mainly encountered soon after planting and during vegetative growth of maize.

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