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"The Potential Areas for Crop Development in Morotai Island Regency, Indonesia"

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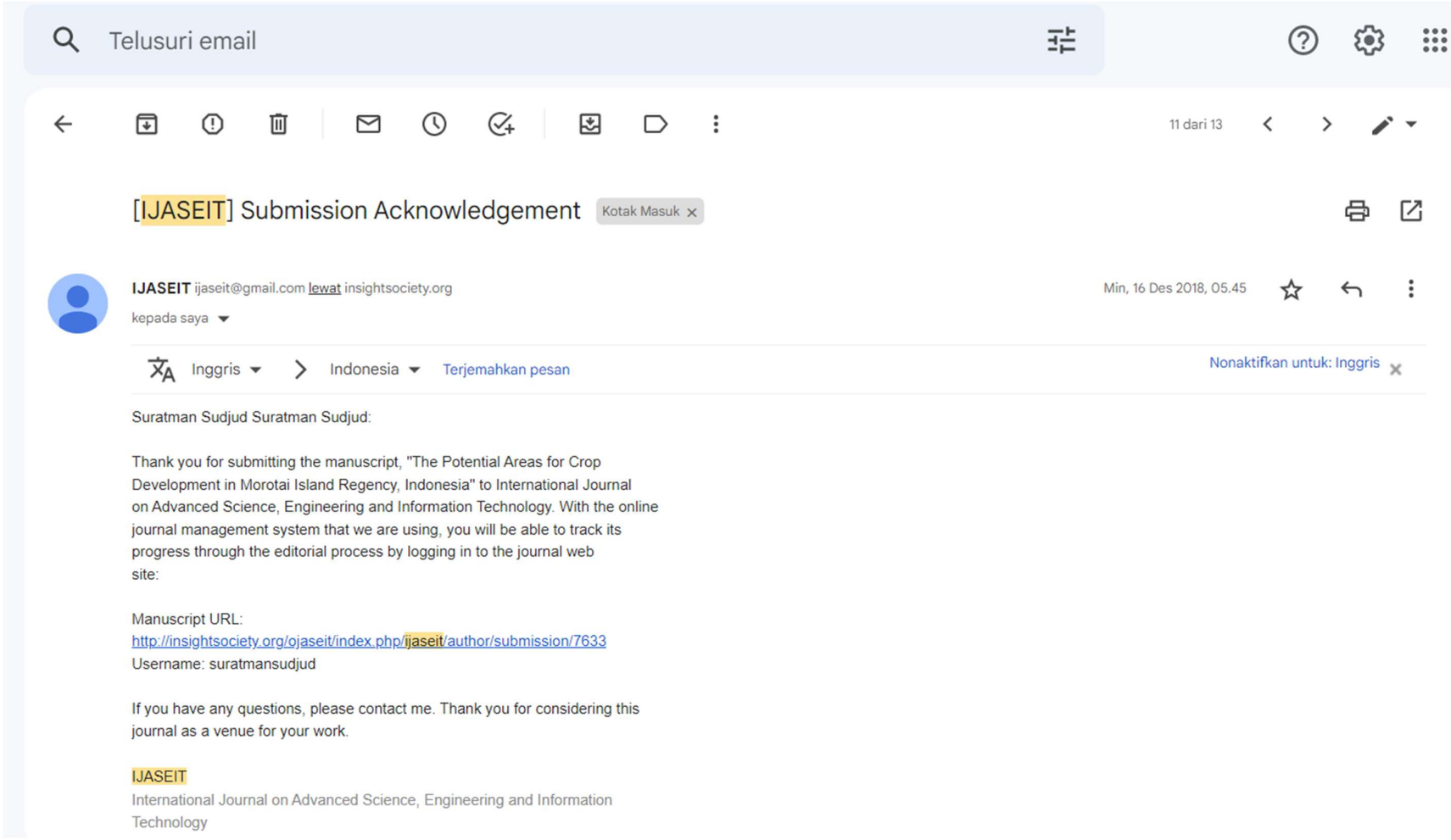

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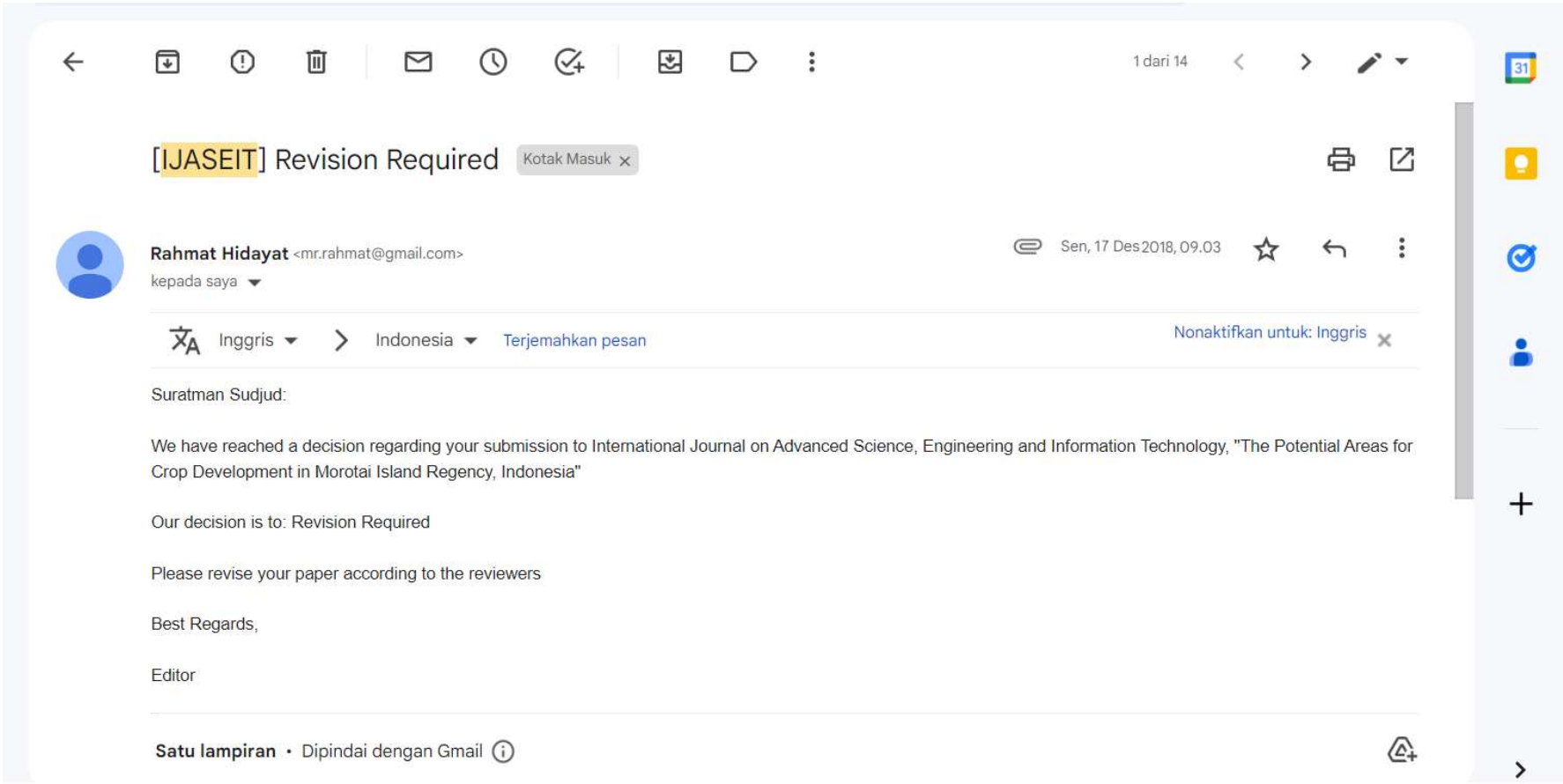

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The Potential Areas for Crop Development in Morotai Island Regency, Indonesia

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***Abstract*— The needs of food in Morotai Island Regency always increase over time, along with the increase in population. On the other hand, the available food potential is still low in productivity to meet the needs. Crop development in Morotai Island Regency, as an effort to fulfill local food needs, can still be done because the land resources potential is available and not optimally utilized. Agricultural land is the main resource for rural community development and food supply. The objectives of this research are: (1) To find out the potential of land resources and availability for crop development in Morotai Island Regency; (2) Identifying the advantages and prospects of crop development in Morotai Island Regency and (3) Preparing the recommendations for the development and management of land for crops in Morotai Island Regency. Data analysis consists of the needs and advantages of crops, farming feasibility, income, revenue, and land suitability. The results show that the suitable (S) land potential for the development of crops reaches 55,624.7 ha. Potentially suitable land for lowland rice, which classified as sufficiently suitable (S2), reaches 34,290.5 ha and marginally suitable (S3) land reaches 7,282.5 ha. Sufficiently suitable (S2) and marginally suitable (S3) lands for upland rice reach 25,040.3 ha and 28,932.8 ha respectively. As for corn cultivation, sufficiently suitable (S2) land reaches 25,040.3 ha and marginally suitable (S3) lands reaches 28,932.8 ha. Leading crop/s in South Morotai District are lowland rice and corn; Southwest Morotai is lowland rice; East Morotai are lowland rice and upland rice; North Morotai is upland rice; and Morotai Jaya are upland rice and corn.**

Keywords— Food need, land requirement dan land suitability

I. INTRODUCTION

Food is anything that comes from biological sources of agricultural, plantation, forestry, fishery, livestock and waters products, as well as water, both processed and unprocessed, which are intended as foods or drinks for human consumption, including food additives, food raw materials, and other materials used in the process of preparing, processing and/or making foods or beverages.

The potential crops in Morotai Island Regency includes lowland rice, upland rice, corn, cassava, sweet potato and peanuts. The size of crop development areas in 2017 reached 1,450 ha for lowland rice, 622 ha for upland rice, 155 ha for corn, 135 ha for cassava and 62 ha for sweet potato. Productivity of each crop reached 3.0 tons/ha for lowland rice, 2.0 tons/ha for upland rice, 3.1 tons/ha for corn, 4.0 tons/ha for cassava and 3.1 tons/ha for sweet potato. Food productivity in Morotai Island Regency, based on these data, is still low compared to the cultivation area developed.

Food needs in Morotai Island Regency always increase over time along with the increase in population. On the other hand, the available food potential is still low in productivity to meet the needs. Crop development in Morotai Island Regency, as an effort to fulfill local food needs, can still be done because of the land resources potential is available and not optimally utilized. Agricultural land is the main resource for rural community development and food supply [1]-[3].

To develop crops in Morotai Island Regency, it is necessary to conduct the Mapping of Potential Areas for Crop Development [4]-[8]. The objectives of this research are: (1) To find out the potential of land resources and availability for crop development in Morotai Island Regency; (2) Identifying the advantages and prospects of crop development in Morotai Island Regency and (3) Preparing the recommendations for the development and management of land for crops in Morotai Island Regency..

II. MATERIAL AND METHOD

Morotai Island Regency is a border regency located in the northern end of Eastern Indonesia. Geographically, Morotai Island Regency is located between 2° 00'- 2° 40' N and 128° 15'- 129° 08' E. Land biophysical data collection was carried out in May - September 2018. Land biophysical data collection used survey method with the analytical approach and an approach of free survey observation distance combined

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with transects, as well as boring and complete profiles observation types. Socioeconomic data were collected using Expert Acquisition and Focus Group Discussion.

The analysis of food needs used the following formula:
Food Needs = KP x JP x 365 days

Where: KP = Food consumption per capita
JP = Population number

The analysis of the advantages of crop commodities used Location Quotient (LQ) analysis to see the basic or non-basic sectors of a planning area and it can identify the leading sectors or comparative advantages of a region. Location Quotient (LQ) analysis used the following equation:

$$LQ = \frac{Xij/Xi.}{X.j/X..}$$

Where;

Xij = Harvested area of commodity j in district i (ha)

Xi. = Total harvested area in district i (ha)

X.j = Total harvested area of commodity j in all districts (ha)

X.. = Total harvested area in all districts (ha)

The feasibility analysis of farming is intended to determine the feasibility of crop cultivation economically. Economic feasibility measures include the Benefit Cost Ratio, where a farm is said to be feasible if the Net BCR ratio is more than 1 and BCR ration is more than 0. Benefit Cost Ratio or Net BCR is a comparison between the value of all yields obtained now with the value of all current business costs, formulated with the following equation:

$$NetBCR = \sum_{t=1}^{n} (B_t - C_t)/(1+i)^t$$

B_t = Benefit obtained by a farm in the t-th period (year, month, week, etc.) (Rp)

C_t = Cost incurred by a business in the t-th period (Rp)

i = Interest rate (%)

t = Period (1,2,3,...,n)

Farming net income, according to [11], [12] is the difference between the total revenue (TR) and the total cost incurred in a farm (TC), which is formulated by the equation:

$$\pi = TR - TC$$

The total farm income (TR) is the multiplication of the i-th crop production (Yi) with the price of the i-th crop production (Pyi), formulated by the equation:

$$TR = Y_iP_{yi} = \sum_{i=1}^{n} (Y_1P_{y1} + Y_2P_{y2} + Y_3P_{y3} + \ldots\ldots Y_nP_{yn})$$

The total cost of farming (TC) is the total cost incurred from a direct or indirect farming business, formulated by the equation:

$$TC = FC + VC$$

$$VC = X_iP_{xi} = \sum_{i=1}^{n} (X_1P_{x1} + X_2P_{x2} + X_3P_{x3} + \ldots\ldots X_nP_{xn})$$

Where : TR = Total revenue of farming
TC = Total cost of farming
VC = Variable cost (not fixed)

The land suitability analysis used simple limitation method by comparing the land characteristics of the study area with the requirements of lowland rice, upland rice and corn to grow [5]-[8], [9], [10].

III. RESULT AND DISCUSSION

A. The Physical Potential of Research Area

Climate type in the study area, according to the Schmidth and Ferguson classification system (1951), is classified as climate type B (wet) with the average dry months < 60 mm as many as ± 2.0 months and wet months > 100 mm as many as 9.4 months with Q index amounting to 21.3%. Based on classification of Oldeman (1975) in Hadun et al. (2016), classified as agroclimate zone C2 where the average wet months (BB> 200 mm) is 5 months and the average dry months (BK <100 mm) is 3 months.

The topography of Morotai Island Regency, based on the mapping and analysis results, is dominated by very steep topography (> 65%) with an area of 71,503.8 ha (30.5%). Suitable topographical conditions for the development of crops are between flat (0-3%) to wavy (8- 15%) with a total area of 57,539.2 ha (24.5%).

Geological conditions of Morotai Island Regency, based on the Geological Map of Morotai with a scale of 1: 250,000 in 1980, there were 4 geological formations namely Alluvium (Qa), Coral Limestone (Qt), Weda (Tmpw) and Bacan (Tomb) Formations.

Landforms in Morotai Island Regency, based on the accompanying geomorphic process, can be classified according to the Landform Classification system LREP II [11] into five groups, namely alluvial (A), Marine (M), karst (K), volcanic (V) and tectonic/structural (T) landforms. Landform distribution in Morotai Island Regency is dominated by tectonic landform (T), covering an area of 85,590.7 ha (36.5%), and volcanic landform (V), covering an area of 81,542.8 ha (34.8%). As for the karst landform (K) has an area of 47,229, 3 ha (20.1%), alluvial landform (A) covering an area of 15,856.8 ha (6.8%) and Marine landform (M) covering an area of 3,566.2 ha (1.5%). Soil distribution in Morotai Island Regency, based on the results of mapping, is dominated by associations of Eutric Cambisol ad Lithic Cambisol covering an area of 105,152.4 ha (44.8%).

B. Crop Potential

The area for crop development in the Morotai Island Regency, in the last five years, was dominated by lowland rice and tended to increase. The average land area of lowland rice cultivation reaches 1,148 ha. The graph of area development of crop land is in Figure 1.

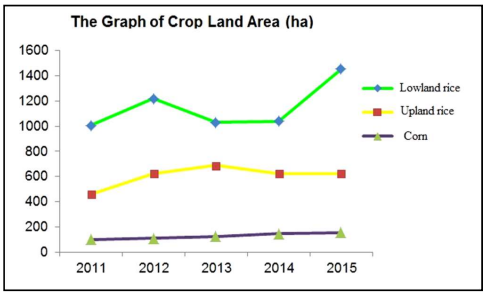

Fig 1. The graph of crop land area development

Harvested area of crops in Morotai Island Regency was dominated by lowland rice with an average of 497 ha, then upland rice of 348 ha. While other crop, such as corn, had an average of 92.5 ha. The graph of crop harvested area development is in Figure 2.

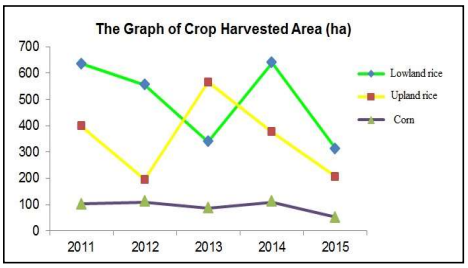

Fig 2. The graph of harvested crop area development

The average crop productions in Morotai Island Regency were 1,491 tons/year for lowland rice, 700 tons/year for upland rice and 261.6 tons/year for corn. Food crop production in Morotai Island Regency has fluctuated and tended to decline in the last five years. The graph of food crop production development is in Figure 3.

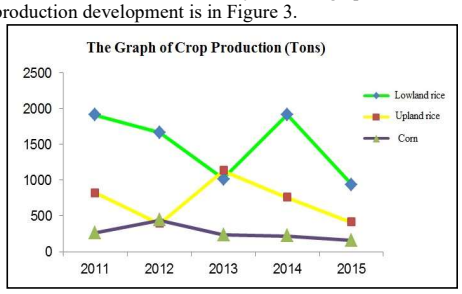

Fig 3. The graph of crop production development

The average crop productivity in Morotai Island Regency included lowland rice and corn by 3.0 tons/ha, as well as upland rice by 2.0 tons/ha. Crop productivity in Morotai Island Regency has fluctuated and tended to decline in the last five years. The graph of crop productivity development is in Figure 4.

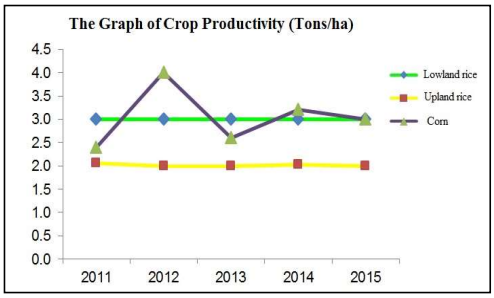

Fig 4. Graph of food crop productivity development

C. Land Suitability Analysis

The potential land, suitable (S) for lowland rice based on the evaluation results, reaches 41,573.0 ha (17.8%) with the composition of sufficiently suitable (S2) class covering an area of 34,290.5 ha (14.7%) and marginally suitable (S3) class covering 7,282.5 ha (3.1%). While the not suitable (N) land for lowland rice is 192,212.7 ha (82.2%) with the composition of temporarily not suitable (N1) land covering an area of 39,106.1 ha (16.7%) and permanently not suitable (N2) covering 153,106.6 ha (65.5%). The results of the potential land suitability evaluation for lowland rice are shown in Table 1.

TABLE 1. Suitability of Potential Lands for Lowland Rice Cultivation

No	Land Suitability	Limiting Factors	Area	
			Ha	%
1	Sufficiently Suitabile (S2)		34,290.5	14.7
	S2rb	Media for rooting, flood hazard	564.9	0.2
	S2r	Media for rooting	24,475.4	10.5
	S2re	Media for rooting, erosion hazard	9,250.2	4.0
2	Marginally Suitabile (S3)		7,282.5	3.1
	S3re	Media for rooting, erosion hazard	7,282.5	3.1
3	Temporarily not Suitabile (N1)		39,106.1	16.7
	N1r	Media for rooting	1,651.6	0.7
	N1p	Land preparation	12,400.1	5.3
	N1re	Media for rooting, erosion hazard	10,937.4	4.7
	N1e	Erosion hazard	14,117.1	6.0
4	Permanently not Suitabile (N2)		153,106.6	65.5
	N2rb	Media for rooting, flood hazard	1,914.6	0.8
	N2e	Erosion hazard	151,192.0	64.7
	Total		**233.785.7**	**100.0**

The potential land, suitable (S) for upland rice based on the evaluation results, reaches 53,973.1 ha (23.1%) with the composition of sufficiently suitable (S2) class covering an area of 25,040.3 ha (10.7%) and marginally suitable (S3) class covering 28,932.8 ha (12.4%). While the not suitable (N) land is 179,812.6 ha (76.9%) with the composition of temporarily not suitable (N1) land covering an area of 26,706.1 ha (11.4%) and permanently not suitable (N2) covering

153,106.6 ha (65.5%). The results of the potential land suitability evaluation for upland rice are shown in Table 2.

TABLE 2. Suitability of Potential Lands for Upland Rice Cultivation

No	Land Suitability	Limiting Factors	Area	
			Ha	%
1	Sufficiently Suitabile (S2)		25,040.3	10.7
	S2rb	Media for rooting, flood hazard	564.9	0.2
	S2r	Media for rooting	20,891.2	8.9
	S2re	Media for rooting, erosion hazard	3,584.1	1.5
2	Marginally Suitabile (S3)		28,932.8	12.4
	S3p	Land preparation	12,400.1	5.3
	S3e	Erosion hazard	16,532.7	7.1
3	Temporarily not Suitabile (N1)		26,706.1	11.4
	N1r	Media for rooting	1,651.6	0.7
	N1e	Erosion hazard	25,054.5	10.7
4	Permanently not Suitabile (N2)		153,106.6	65.5
	N2rb	Media for rooting, flood hazard	1,914.6	0.8
	N2e	Erosion hazard	151,192.0	64.7
	Total		**233,785.7**	**100.0**

The potential land, suitable (S) for corn based on the evaluation results, reaches 53.973,1 ha (23,1%) with the composition of sufficiently suitable (S2) class covering an area of 25.040,3 ha (10,7%) and marginally suitable (S3) class covering 28.932,8 ha (12,4%). While the not suitable (N) land is 179.812,6 ha (76,9%) with the composition of temporarily not suitable (N1) land covering an area of 26,706.1 ha (11.4%) and permanently not suitable (N2) covering 153,106.6 ha (65.5%). The results of the potential land suitability evaluation for corn are shown in Table 3.

TABLE 3. Suitability of Potential Lands for Corn Cultivation

No	Land Suitability	Limiting Factors	Area	
			Ha	%
1	Sufficiently Suitabile (S2)		25,040.3	10.7
	S2rb	Media for rooting, flood hazard	564.9	0.2
	S2r	Media for rooting	20,891.2	8.9
	S2re	Media for rooting, erosion hazard	3,584.1	1.5
2	Marginally Suitabile (S3)		28,932.8	12.4
	S3p	Land preparation	12,400.1	5.3
	S3e	Erosion hazard	16,532.7	7.1
3	Temporarily not Suitabile (N1)		26,706.1	11.4
	N1r	Media for rooting	1,651.6	0.7
	N1e	Erosion hazard	25,054.5	10.7
4	Permanently not Suitabile (N2)		153,106.6	65.5
	N2rb	Media for rooting, flood hazard	1,914.6	0.8
	N2e	Erosion hazard	151,192.0	64.7
		Total	233,785.7	100.0

D. Analysis on Leading Crop Commodities

LQ analysis in determining the basic or leading commodities used the harvested area (ha) and crop productivity (ton/ha) of crops. The 'LQ Harvested Area' is an illustration of the suitability of commodity development with agro-climate conditions which include climate, soil and topography. While 'LQ Production' means that the commodities cultivated in an area have advantages in terms of production per area with certain management. The results of the LQ analysis are found in Table 4.

TABEL 4. Analysis on seeded crop commodities in Morotai Island Regency

No	District	LQ Value	Lowland rice	Upland rice	Corn
1	South Morotai	LQ Cultivation Area	1.02	0.78	1.15
		LQ Production	1.11	0.88	0.88
		Average	1.06	0.83	1.02
2	East Morotai	LQ Cultivation Area	1.04	1.06	0.80
		LQ Production	1.24	0.99	0.99
		Average	1.14	1.02	0.90
3	Southwest Morotai	LQ Cultivation Area	1.60	0.59	0.62
		LQ Production	1.24	0.99	0.99
		Average	1.42	0.79	0.80
4	North Morotai	LQ Cultivation Area	0.67	1.31	0.97
		LQ Production	1.24	0.99	0.99
		Average	0.95	1.15	0.98
5	Morotai Jaya	LQ Cultivation Area	-	1.79	1.87
		LQ Production	-	1.20	1.20
		Average	-	1.49	1.53
Average LQ value in Morotai Island Regency			**1.14**	**1.06**	**1.05**

As for crop development, based on the results of LQ analysis on the harvested areas, shows that the basic crops in South Morotai District are lowland rice and corn. East Morotai District is the base for lowland and upland rice development. Southwest Morotai is the base for lowland rice development. North Morotai District is the base for upland rice development [13]. While Morotai Jaya is the base for developing upland rice and corn.

E. Crop Development Analysis

The analysis of crop development was based on the results of land suitability evaluation, the spatial pattern plan of Morotai Island Regency, the existing land use and land requirements to meet the food consumption of the population.

The results of the analysis obtained four patterns of crop development in Morotai Island Regency, namely 1). Development of wetland crops covering 1,806.5 ha, 2). Development of dryland crops covering 5,274.6 ha, 3). Development of dryland and plantation crops covering 9,255.5 ha and 4). Development of plantation and dryland crops covering 36,925.0 ha. The size of areas for crop development pattern in each sub-district in Morotai Island Regency is found in Table 5.

TABLE 5. The area of crop development land di Morotai Island Regency

No	Crop Development Pattern	South Morotai	Southwest Morotai	East Morotai	North Morotai	Morotai Jaya	Area	
							Ha	%
1	Wetland Foods	263.3	514.6	170.3	858.3	-	1,806.5	3.4
2	Dryland Foods	1,684.8	819.2	657.5	2,113.1	-	5,274.6	9.9
3	Dryland Foods + Plantation	3,378.8	2,396.6	1,831.8	1,163.0	485.4	9,255.5	17.4
4	Plantation + Foods	10,224.6	8,272.9	3,650.2	10,756.6	4,020.8	36,925.0	69.3
Total		**15,551.5**	**12,003.3**	**6,309.7**	**14,890.9**	**4,506.2**	**53,261.6**	**100**

Source : Data analysis in 2018

Development of wetland crops in Morotai Island Regency is carried out on sufficiently suitabile land (S2) land with land-limiting factors including media for rooting, available nutrients and flood threats. Lands for crop development are in the zone of Wetland Crops (Tanaman Pangan Lahan Basah/TPLB) with the existing lands are used for lowland rice cultivation and part of it is swamp forest land. The type of recommended plant is lowland rice. Conditions of crop development in Morotai Island Regency are found in Table 6.

TABLE 6. Conditions of crop development based on land suitability, spatial pattern plan and existing land use in Morotai Island Regency

No	Crop Development Pattern	Land Suitability	Spatial Pattern Plan of Morotai Island Regency	Existing Land Use	Types of Developed Crop
1	Wetland Foods	S2	Wetland Crops	Paddy field, swamp forest	Lowland rice
2	Dryland Foods	S2,S3	Dryland Crops	Dry paddy field	Upland rice, corn, cassava, sweet potato, peanut,
3	Dryland Foods + Plantation	S2,S3	Dryland and Plantation Crops	Shrubs, secondary forest	Upland rice, corn, cassava, sweet potato, peanut,
4	Plantation + Foods	S2	Dryland and Plantation Crops	Plantation	Cassava, corn, peanut

Source : Data analysis in 2018

Development of dryland crops in Morotai Island Regency is also carried out on sufficiently suitabile (S2) and marginally suitabile (S3) lands with land-limiting factors including water availability, media for rooting, nutrient retention, available nutrients, land preparation, flood threats and erosion hazards. Based on the spatial pattern plan, Morotai Island Regency is located in the zones of Dryland Crops (Tanaman Pangan Lahan Kering /TPLK) and plantation crops. The existing lands are used as dry paddy fields, plantations, shrubs and secondary forests. Development of dryland crops in shrub and forest areas can be cultivated extensively, while in plantation areas can only be cultivated narrowly because the land is mostly covered with plantation crops.

IV. Conclusions

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Based on the results of the research carried out in Morotai Island Regency, the conclusions are as follows:

1) The potential of suitabile land (S) for crop development in Morotai Island Regency reaches 55,624.7 ha.
2) The suitabile land potential for lowland rice cultivation, which classified as sufficiently suitabile (S2), reaches 34,290.5 ha and 7,282.5 ha classified as marginally suitabile (S3). As for the upland rice cultivation, an area of 25,040.3 ha classified as sufficiently suitabile (S2) and an area of 28,932.8 ha classified as marginally suitabile (S3). Meanwhile, an area of 25,040.3 ha and 28,932.8 ha are sufficiently suitabile (S2) and marginally suitabile (S3) for corn cultivation respectively.
3) Leading crop/s in South Morotai District are wetland rice and corn; Southwest Morotai is mostly lowland rice; East Morotai is lowland rice and upland rice; North Morotai is upland rice; and Morotai Jaya are upland rice and corn.

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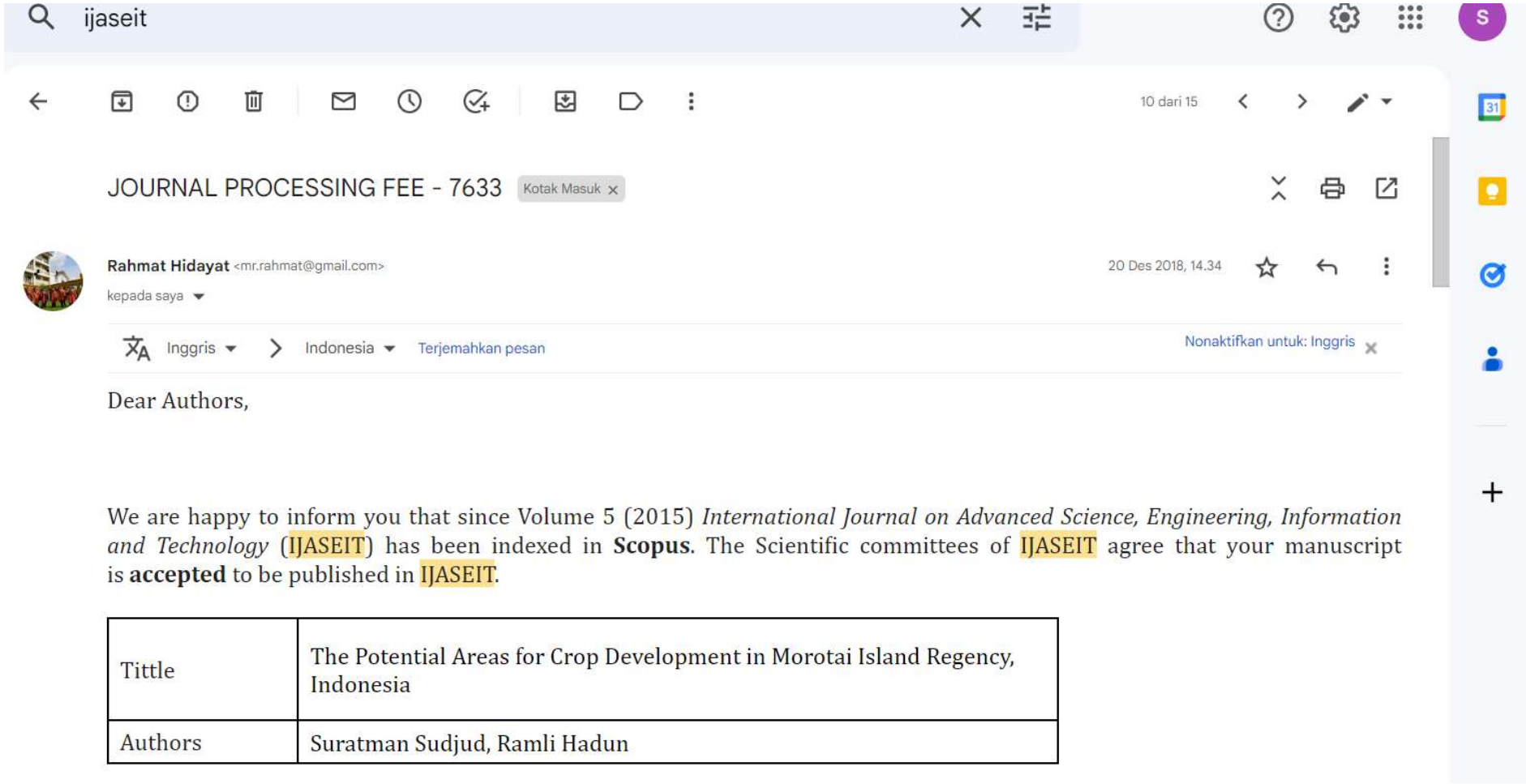

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