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## Transportation model and techno economic as useful tools in agroindustry clustering: a case study in district Semangga, Merauke

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**Abstract.** Merauke Regency has agriculture potency which has not been fully explored. The ultimate goal of the study is developing an integrated food estate in Merauke. Among initial efforts have been done to achieve the final goal were (1) determining the suitability of land for some food crops, (2) preparing zoning maps to support the agriculture industry clustering for Semangga district. The method used was primarily land and water survey on selected sampling sites in each zone. Zoning of land suitability will support clustering efforts of the agricultural industry in Papua. Based on land suitability analysis and the mapping of supporting resources as an effort to develop an integrated food estate, overall connectivity system of main suppliers between clusters were then being analysed. The two main tools used to minimize total costs associated with the rice supply chain in these clusters were Transportation Model and Techno Economic analysis. Transportation model was used to minimize the overall costs associated from paddy cultivation to rice distribution, while techno economy analysis was used to determine overall feasibility study of agriculture industry clustering in District Semangga – as a benchmark for further study in Merauke District.

### 1. Introduction

Merauke district, Papua, Indonesia consists around two million hectares of non-cultivated land area [1]. In recent years this district was proclaimed as the Future National Food and Energy Barn. To support the development of agriculture in Merauke, the authors conducted two year research on land suitability and zoning of food production in Papua. The research was done in Semangga district – which serve as a pilot study with the final goal of providing a framework on how to build agricultural-based industry clustering in Merauke.

The first year of research has the objective to determine suitability of Merauke land for some food crops. The research was primarily based on a field survey in which various analysis as well as soil sampling was performed at selected sampling sites for each zone in district Semangga, Merauke. The parameters surveyed include soil, water, temperature regime and topography based on sample taken from 50 point locations. The main criterion applied is the optimal land use, i.e. the exploitation of land which yields maximum profit with the minimal expenditures. Based on both actual and potential land suitability analysis – the analysis showed that most of the sites belong to S3n class with the availability of P as the main limiting factor. The study concluded that the district is promising to be the next national food barn after array of required improvements. Should the recommended

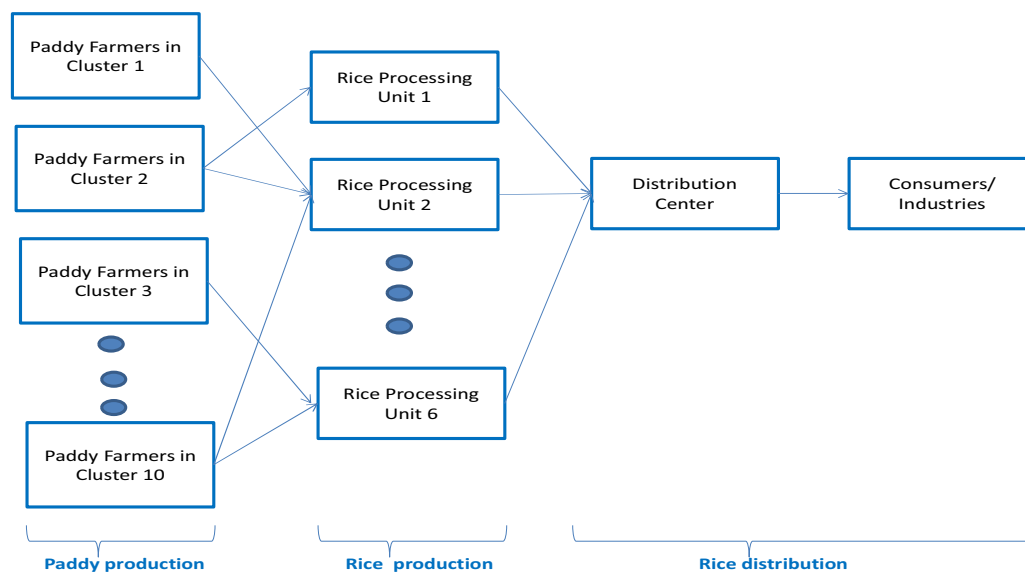


improvements performed – the total area of land would be suitable for rice production can be increased from 360 ha to 22,303 ha [5].

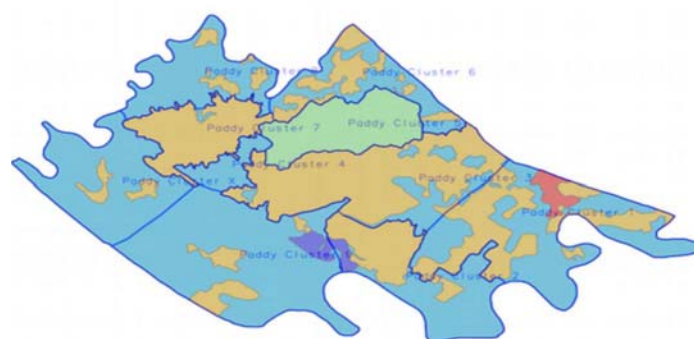
This paper discusses how two quantitative analysis models - transportation model as well as techno economy analysis - were carried out in the second year of study in attempt to create agricultural industry clusters which optimize the overall profitability of the system.

## 2. Research methodology

Transportation Model deployed in this research to determine agroindustry (rice) zonation is depicted in Figure 1, while the ten clusters as well as the six rice milling units being considered is depicted in Figure 2. The model was chosen, according to the results of previous research [3] which stated that most farmers sell their produce to big traders (rice mill facilities).



**Figure 1.** Transportation model to minimize total costs associated with rice production and distribution in Semangga District



**Figure 2.** Paddy clustering in District Semangga [6]

The linear programming for the transportation model as illustrated above – taking into account 120 decision variables (combination of two different land suitability areas in each cluster and six milling services) and 27 constraints. It is written and run in SAS-EG 7.1. as simplified below:

```
proc optmodel;
/* declare variables */
var
x11 >= 0, x12 >= 0, x13 >= 0, x14 >= 0, x15 >= 0, x16 >= 0,
x21 >= 0, x22 >= 0, x23 >= 0, x24 >= 0, x25 >= 0, x26 >= 0,
.....
x91 >= 0, x92 >= 0, x93 >= 0, x94 >= 0, x95 >= 0, x96 >= 0,
x01 >= 0, x02 >= 0, x03 >= 0, x04 >= 0, x05 >= 0, x06 >= 0,
y11 >= 0, y12 >= 0, y13 >= 0, y14 >= 0, y15 >= 0, y16 >= 0,
y21 >= 0, y22 >= 0, y23 >= 0, y24 >= 0, y25 >= 0, y26 >= 0,
.....
y91 >= 0, y92 >= 0, y93 >= 0, y94 >= 0, y95 >= 0, y96 >= 0,
y01 >= 0, y02 >= 0, y03 >= 0, y04 >= 0, y05 >= 0, y06 >= 0;
/* minimize objective function (cost) */
minimize profit =
163*x11 + 117*x12 + 129*x13 + 126*x14 + 141*x15 + 142*x16 +
103*x21 + 83*x22 + 68*x23 + 74*x24 + 60*x25 + 59*x26 +
.....
911*y91 + 945*y92 + 929*y93 + 950*y94 + 925*y95 + 933*y96 +
879*y01 + 926*y02 + 913*y03 + 934*y04 + 913*y05 + 921*y06;

/* subject to constraints */
con process1: x11 + x12 + x13 + x14 + x15 + x16 <= 4040;
con process2: x21 + x22 + x23 + x24 + x25 + x26 <= 2246;
.....
con process27: x11 + x21 + x31 + x41 + x51 + x61 + x71 + x81 + x91 + x01 + y11 + y21 + y31 + y41 + y51 +
y61 + y71 + y81 + y91 + y01 +
x12 + x22 + .....
x16 + x26 + x36 + x46 + x56 + x66 + x76 + x86 + x96 + x06 + y16 + y26 + y36 + y46 + y56 + y66 + y76 + y86
+ y96 + y06 >= 6000;
/* solve LP using primal simplex solver */
solve with lp / solver = primal_spx;
```

The model assumed that every hectare of rice plantation produces 5 tons, in all clusters. Transportation cost per ton per unit distance is assumed to be the same in all regions across District Semangga. In addition to milling capacity in each milling unit, as a limiting condition, the total area of land used for rice cultivation in the Semangga area is set to be 6,000 ha. Therefore the locations considered only include locations with S2wfn and S3n land suitability classes with a total potential area that far exceeds the 6000 ha target. The area for each location is rounded up to the nearest tens of ha to simplify. Based on the above explanation, the accuracy of the model outputs is a function of the accuracies of the above assumptions.

The Output of the transportation model is then used as an input to the techno-economic analysis of rice production and distribution in Semangga District. The analysis will determine financial feasibility of the proposed system.

### 3. Results and discussion

The final output of the transportation model is: the area in each cluster used for rice production in the Semangga district (differentiated between area ready for plantation and area requiring land and or drainage improvements). Based on the results, one can estimate total costs needed for land conversion for paddy estate and fees associated with required drainage repairs in the area.

The total rice production and distribution costs considered in the transportation model include conversion / land preparation costs (Rp. / ha.year) + farming costs (Rp. / ha) + harvesting costs (Rp. / ha) for each location + transportation costs to the distribution / milling unit + rice milling costs. It is assumed that the production costs and harvesting costs per ha for each location are the same, as well as the unit of transportation costs / km and the cost of rice milling. So, the two differentiating factors are

the cost of required land treatments in each location and the distance between the farming location to milling center. Required land treatments in each location can be classified as follows:

- (1) Land conversion cost / ha: the estimated cost to apply some specific technology so that potential-land status can be increased to ready-to-use land
- (2) Land repair costs are/ha: the estimated costs of some required treatments / ha on land classified as 'ready for planting'.

**Table 1.** Detail land suitability level for each cluster

Cluster	N1n	N2f	S2wfn	S3n	S3np	Grand Total
1	2,336	308		3,324		5,968
2	1,385		128	1,892		3,404
3	4,347			915		5,262
4				703		703
5					2,432	2,432
6	1,010			1,424		2,434
7	2,079			38		2,117
8	318			2,171		2,489
9	615			5,657		6,505
10	262		232	3,389		3,652
Total	12,353	308	360	19,513	2,432	34,966

**Table 2.** Summary of the feasibility analysis

No.	Stage	Area (ha)	Cost/ha (1000 RP)	Total (Million Rp)
1	Seeding	6,000		
	Seeds		200	1,200
	Labor		1,000	6,000
2	Tillage	6,000	2,500	15,000
3	Fertilizing	6,000		
	Fertilizer		375	2,500
	Labor		1,600	9,600
4	Cultivating/planting	6,000		
	Labor		1,000	6,000
5	Plant maintenance	6,000		
	Weeding (2 times)		1,500	9,000
	Refining (7-10 days)		150	900
	Pesticide application	6,000		
	Pesticide		650	3,900
	Labor		600	3,600
6	Harvesting	6,000	750	4,500
	Depreciation	6,000	40	240
7	Transportation costs	6,000	24	144
<b>Total</b>				<b>62,334</b>
Estimated Yield		Ton/ha	ha	
		5	6,000	150,000
			Rp/kg	
			5,000	
			R/C	2.4

The optimization results suggested in order to obtain a twenty percent paddy farming area increase from the 2016 target (i.e. A total area of 6000 ha each season in the Semangga district for paddy estate) - it is recommended to concentrate the efforts to clusters 2,3,4 and 5 only.

Mapping optimization results to land suitability analysis as given in Table 1 [5] provided the following info:

Cluster 2: 1,320 ha 'ready-for-planting' land with suitability level of N1n

Cluster 3: 3,960 ha 'ready-for-planting' land with suitability level of N1n

Cluster 4: 295 ha 'ready-for-planting' land with suitability level of S3n

Cluster 5: 425 ha 'ready-for-planting' land with suitability level of S3np

Few things needed to be performed to handle the limiting factors for paddy farming are as follows:

- (1) Irrigation
- (2) Fertilization
- (3) Liming
- (4) Land clearing

The costs associated with the above treatments for each land suitability level were carefully estimated. The estimated costs if all area with land suitability level analysis of S3n, S3np and N1n being treated to get rid of the limiting factors for paddy farming would be Rp. 5.9 Billion. Assuming cost is linearly proportionate to area, total cost to be invested for land preparation for ((1320+3960) ha N2n + 295 ha S3n +425 ha S3np) would be Rp. 1.8 Billion [6].

Based on the above results and additional info, the feasibility analysis of paddy farming and processing in Semangga District, Merauke was carried out. The results are summarized in Table 2.

#### 4. Conclusion

The transportation model results showed that District Semangga should concentrate paddy farming areas in cluster 2,3,4, and 5 to achieve a 20 percent increase of 2016 target to minimize the overall cost of production and distribution. Interestingly to achieve the target of 6,000 ha there is no need to do land clearing since total area of 'ready-to-use' land (after treatments) is enough to satisfy the goal.

It's estimated that paddy produced in each harvesting season would be 30,000 ton, which means a total of 60,000 ton of paddy each year. Feasibility analysis performed suggested that the proposed industry is financially viable. It is important to note that an integrated analysis for all commodities being considered (Paddy, Corn, etc.) using the same tools as described in this paper is required to determine the optimal agroindustry clustering of Semangga District.

#### References

- [1] Badan Pusat Statistik Kabupaten Merauke 2012 *Merauke Dalam Angka* (Merauke: Badan Pusat Statistik)
- [2] FAO 1981 *Framework for Land Evaluation* (Netherlands : ILRI)
- [3] Marthen A I and Maria M D W 2015 *Agricola* **5** 32–46
- [4] Sahirman S, Rifan M and Ardiansyah 2012 *Laporan Studi Kelayakan Budidaya Tanaman Pangan di Food Estate, Bulungan, Kalimantan* (Purwokerto: LPPM Unsoed)
- [5] Sahirman S, Ardiansyah, Rifan M and Melmambessy E 2016 *International Journal of Agricultural and Biosystems Engineering* **10** 181–183
- [6] Sahirman S, Ardiansyah, Rifan M and Melmambessy E 2016 *Analisa Kesesuaian Lahan untuk Mendukung Kebijakan Klasterisasi Industri Berbasis Pertanian di Kabupaten Merauke, Papua* (Purwokerto : Laporan Akhir Tahun Kedua MP3EI LPPM Unsoed)