

# PRODUCTION OPTIMIZATION AND FOOD NEEDS PROVISION DISTRIBUTION IN SOUTH HALMAHERA REGENCY, NORTH MALUKU

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**Abstract:** Small islands have food development constraints due to their location characteristics which are dispersed and isolated. These small islands have limited capacity of land resource along with low efficiency of food distribution so that it influences sufficiency level of affordable food availability. Therefore, the aims of this research are: (1) to analyze regional food balance to fulfil food and nutrition needs; (2) to analyze the direction of food production development with small island basis; and (3) to analyze the interaction pattern of food distribution among small islands to ensure sufficiency food availability. This research was conducted in March-December 2016 in South Halmahera Regency. This research design is explorative using primary and secondary data. Primary data was collected by observation results, interview, and *Focused Group Discussion* (FGD). The result research shows that land optimization for the development of Wetland Food Crops (TPLB), Dry land Food Crops (TPLK), and Annual Food crops (TPT) are able to fulfil South Halmahera people's food needs and its land availability surplus is 5,159.2; 34,834.9 and 21,971.0 ha. Interaction pattern among small island is needed for food availability from TPLK and TPLB in Bacan and Makian Small Island. Interaction pattern among small islands is needed for rice availability in all sub district of South Halmahera by optimize land resource potential, system recovery of land transportation and port warehouse in every small islands, empowerment of citizen ship in rice distribution from small island centre to every sub districts as well as TPLK and TPT distribution from nearby sub district in the same small island.

**Keywords:** *archipelago, land resource, transportation*

## INTRODUCTION

Food is a basic human need to live and deserve a good quality of life. According to the food importance, thus food availability which has sufficient nutrition and affordable is needed to be ensured by optimization food resource diversification and local culture in every region (Sudaryanto and Rusastra, 2008; Azahari, 2008). This strategy is relevant in reaching food security development in Indonesia which has archipelago characteristic with food supply potential and transportation system which is different in each region (Manuwoto dan Martianto, 2008).

Food security development program in Indonesia has been successfully increasing national

food availability. However, it is not a good measurement in ensuring food security status in each region (Bantacut, 2013). The result of region mapping shows that 100 regions/cities are categorized as very low food security by the fact that 80% of them are located in East Indonesia Region. This region are focused on the small islands: NTB, NTT, Maluku, North Maluku, Papua, and West Papua and there are 50 regencies/cities. Availability factor of food quantity and type, food access ability, and affordable food price are being obstacles in reaching food security status in East Indonesia region (Rachmaningsih, 2012).

East Indonesia is dominated by small island area which is dispersed and isolated. It will affect the efficiency of affordable food availability

(Connell, 2015). Small island has land capacity limitation which can be beneficial so that it influences food and non-food production activity scale and type (Hay and Mimura, 2013). For instance, food production level in North Maluku has not meet people's food needs, except for tuber crops food, and animal protein while for paddy/cereals, nuts, vegetable, fruit and spices as much as 39; 47; 17 and 2% in order.

Small island also has impacts in the limitation of transportation system availability to serve product distribution from and to dispersion islands (Pelling and Uitto, 2001). Transportation obstacle affects a high production cost which has to be spent per transportation unit so that it influences people ability in optimizing any business opportunities (Purwaningsih, 2008). Because of the low business utilization, people's income is also low. In average, it is only IDR 3,429,000 for people's income in NTB, NTT, Maluku, North Maluku, Papua, and West Papua while IDR 9,572,000 is national income (BPS, 2013). For that reason, these small islands has low characteristic of provision ability and food economic access due to land resource limitation and business opportunity utilization (Adrianto and Matsuda, 2004).

Transportation system which is limited will also affect the efficiency of food distribution in each dispersed islands. Distance, increasing in fuel price, and distribution availability are obstacles in reaching affordable food price (Ridhwan, Karlina, dan Yanfitri, 2012). Compared to any other region, food price in East Indonesia has relatively higher price, except for rice commodity. Maluku and North Maluku Province has higher different price in cooking oil and red chilli: IDR 2400,- and IDR 8,000 while higher price for onion and sugar is in Papua-West Papua: IDR 9500,- and IDR 1200,- (Ridhwan, dkk, 2012). Therefore, people who live in East Indonesia have high pressure in fulfilling

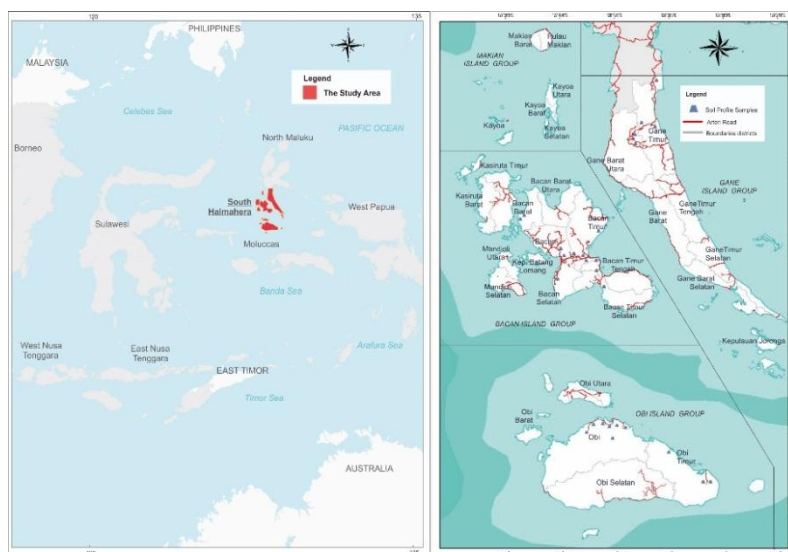
food needs due to low income and unaffordable food price.

South Halmahera is one of regions which is categorized as low food security in East Indonesia (BKP, 2009). It consists of Bacan Island, Kasiruta Island, Mandioli Island, Obi Island, Bisa Island, Gura Ici Islands, Makian Islands, Batang Lomang Islands, dan Joronga Islands. Sustainability food security development in South Halmahera Islands are done by the approach of production optimization and food distribution with small island basis to make sure affordable food availability and food access ability for people. The strategy of food production optimization concerns on land ability and compatible in order to maintain sustainable resource utilization and ecological function as well as the ability of independently fulfilling food needs (Dahuri, 2008; Widiatmaka, *et al*, 2015). Distribution optimization strategies are done by optimizing region production ability so that food distribution pattern which is efficient with intra and among small islands is able to be reached (Lokollo, 2012). In this case, food needs have expenditure consumption allocation as much as (50-60%) compared to any other needs. Thus, food production optimization activities are alternative strategy in increasing people's income in order to have good food access (Bantacut, 2013).

The aims of this research are: (1) to analyze regional food balance to fulfil food and nutrition needs; (2) to analyze the direction of food production development with small island basis; and (3) to analyze the interaction pattern of food distribution among small islands to ensure sufficiency food availability.

## METHODS

This research was conducted in South Halmahera Regency and geographically, its coordinate lies on 126° 45' - 129° 30' BT dan 0°30' LS - 2°00' LU with 22% of land area (Picture 1) as following:



**Figure 1.** Research location in South Halmahera and North Maluku

This area is dominated by small dispersed small islands. Obi Island is the largest island which has 2,543 km<sup>2</sup> of land area so that all South Halmahera Regency is categorized as small island criteria, except Gane which is located in the Halmahera big island.

The characteristics of South Halmahera people's distribution are 21% in Obi Islands, 16% in Makian Islands, 20% in Gane Islands, 32% in Bacan Island, and 12% in the outside of Bacan Island. South Halmahera is dominated by the mountains (>40%) as much as 218.462 ha (26.8%). In this study, South Halmahera Regency is divided by 4 island groups: Bacan, Gane, Obi dan Makian.

#### **Ideal Balance of Food Needs-Availability**

Food Needs-Availability Balance is identification of food crops land area status that is available towards land area needs to produce nutritional foods. Food needs are calculated refers to the national index of energy availability (IEA) which is 2,200 kcal/capita/day. Energy contribution for each food groups in fulfilling total energy needs per capita/day is calculated by using Desirable Dietary Pattern (DDP) (Hardinsyah, Madanijah dan Baliwati, 2002). Desirable Dietary Pattern (DDP) shows food consumption diversification according to energy contribution in each food groups (**Table 1**).

Food needs are calculated by the assumption of constant growth rate, constant food

crops's productivity, and food needs are only for people's consumption, as well as age composition is close to national people's composition (Absari, 2007; Sumarlin, 2009). The total people in South Halmahera Regency in 2021 are predicted as much as 247,571 with 2.1% of growth rate.

Food availability is calculated according to the total calorie availability from the total land area for food crops that can be produced and consumed in certain time. The total calorie availability per year is measured by the energy composition per 100 gr in each food crops and production conversion factor (ton) to kcal to get total energy that is able to be consumed by people (Departemen Kesehatan, 1996). Production assumption for each food crops is remain used to identify the total availability and land needs from the data of food crops production availability and needed to reach people's recommended dietary allowances.

The analysis of Food Needs-Availability Balance is done for five food groups: (1) paddy/cereals, (2) tuber crops, (3) nuts, (4) spices, (5) vegetables and fruits. The result of this analysis will provide deficit information of land balance that has to be developed to produce food crops by optimizing land resource. Crops selection in land resource optimization concerns on consumption pattern and food crops production potential that has been developed in South Halmahera.

Table 1. Food Groups Proportion and Food Needs Standards According to DDP Calculation

No	Food groups	Proportion (%)	Energy Needs Standard		Needs	
			kcal/cap/day	kcal/cap/year	gram/cap/day	gram/cap/year
1	Paddy/Cereals	50	1, 100	401, 500	306	112
2	Tuber Crops	6	132	48, 180	93	34
3	Animal protein	12	264	96, 360	128	47
4	Oil and fat	10	220	80, 300	25	9
5	Oily Seeds	3	66	24, 090	10	4
6	Nuts	5	110	40, 150	29	11
7	Sugar	5	110	40, 150	30	11
8	Vegetable and Fruit	6	132	48, 180	278	101
9	Spices	3	66	24, 090	64	23
Total		100	2,200	803, 000		

### Land Availability

Land used optimization is a way to increase food crops production to fulfil food needs deficit. Land utilization prediction is used by identifying land availability according to forest used and land used status as well as identifying land compatibility and priority to improve food crops.

Land resource availability is identified on sub district scale and potential land availability is identified on district scale. Land use map, forest map, and land use map are used to identify land availability. Land use map is able to be used. While protected forest (HL), production forest (HP), limited production forest (HPT), nature reserve forest (HSA, and water body (TA) is not.

Along with cultivation region and conversion production forest development, so land is used for people's activities. So those, land adjustment in these forests need to be done in order to increase food crops production (Mustafiril, *et al*, 2009). Land used status classifications which are able to be used including open land, grazing land, and shrubbery. While habitation, industrial activities, transportasi availability, crops land, tree crops, primary forest, and mangrove are not.

### Land Used Compatibility and Priority

Land used compatibility is identified by land evaluation by comparing the requirement of biophysics growth with land characteristic (Djaenudin, dkk, 2003). It is determined by the groups of wet land crops (paddy), dry land crops (tomato), and annual crops (durian). Land compatibility evaluation results land dispersion category: strongly compatible (S1), compatible (S2), incompatible (S3), strongly incompatible (N). S1, S2, and S3 are for the land who has low, high enough, and high limitation factor so it affects input rate to increase land productivity according to certain plant development (Widiatmaka, *et al*, 2014). While for N, it has very high limitation factor so it is not worth to be used for all crops development.

Land evaluation results indicate same land compatibility in a land location so that food crops development priority is needed (Mustafiril, *et al*, 2009). Those priorities are: Wetland Food Crops

(TPLB) as first priority, Dry land Food Crops (TPLK) as second priority, and Annual Food crops (TPT) as third priority.

### Optimum Land Used

Land used optimization to meet food needs results information related to optimal land needs balance and potential land availability. Optimum land used projection is identified according to optimum land used ability that can be produced in every planting period per year for each food crops. Land used optimization is TPLB, TPLK, and TPT land used according to food crops.

Potential land area for each crop is proportional composition for ideal land needs over land needs for each food crops. The availability proportion of paddy, maize, cassava, peanut, mug bean, soybean, eggplant, tomato, chilli, and onion are 19.2; 2.5; 7.0; 5.5; 7.6; 6.1; 7.1; 5.3; 16.9; 13.9; and 8.4% in order from TPLK's land needs. Availability proportion for mango, durian, and banana are as much as 50; 28; and 22% from TPT's land needs.

### Food Distribution

Food distribution is improved by transportation system availability which can be reached intra and among small islands interaction pattern. It is for making sure that food availability is sufficient according to production availability for each area.

Food distribution study is descriptively done by doing an observation in transportation network characteristic that supports intra and among small islands food distribution (Jinca, 2009). Some used variable in this observation is: i). Transportation needs volume and location according to food needs and availability balance, ii) sea transportation availability among small islands, iii) Route Distribution structure between regions, iv) ship quantity, frequency, and capacity according to shipping route.

## RESULTS AND DISCUSSION

### Food Needs Land Balance

The information of Land Balance Status to meet food needs-availability is a reference in food provision planning. Land needs-provision balance status according to food groups is showed in **Table 2**. The availability of actual planting land for food crops in the regency cannot fulfil ideal food needs in 2021: paddy, nuts, vegetables, and spices. Paddy

rice in dry land, maize, tuber crops, animal protein, and fruits has self-sufficient level as much as 149; 412; 711; 185; 533; 598; and 122% and these groups has the surplus of planting land availability. Fish has the biggest contribution in fulfilling animal protein food groups with total consumption of 122.7 gr/days while livestock has 3.0 gr/days (Susenas, 2014).

Table 2. Status of Actual Planting Land Availability and Food Needs Projection to Fulfil Ideal Food Needs Deficit in 2021

No	Food Groups	Land Needs	Planting Land Availability	Gap	Has Fulfilled or not
<b>Paddy/cereals groups</b>					
1	Paddy rice	3,200	611	2,589	No
2	Upland Rice	207	309	102	Yes
3	Maize	107	440	333	Yes
<b>Tuber Crops</b>					
4	Cassava	297	2,112	1,815	Yes
<b>Nuts</b>					
5	Peanut	236	179	57	No
6	Mug bean	325	74	251	No
7	Soybean	261	39	222	No
<b>Vegetables</b>					
8	Eggplant	302	18	284	No
9	Yard long Bean	226	0	226	No
10	Tomato	718	39	679	No
<b>Fruits</b>					
11	Mango	172	319	147	Yes
12	Durian	96	512	416	Yes
13	Banana	73	437	364	Yes
<b>Spices</b>					
14	Red Chilli	591	403	188	No
15	Onion	355	15	340	No
<b>Animal Protein</b>					
16	Fish (Ton)	36,821	45,229	8,408	Yes

### Land Used and Cover

Land used and cover are dominated by secondary forest, tree crops/mixed plantation, and shrubbery (**Table 3 and Picture 2**). Food production optimizing can be done in shrubbery, grazing land, open land, and secondary forest. Shrubby and

grazing land used in South Halmahera is largely found in Obi, 46,545 ha (52%) and 11,444 ha (93%). Secondary forest land is relatively large in every small island, except Makian while the largest paddy field is located in Gane Timur Sub District, 2,645 ha (99%). Timur.

Table 3. Land Used and Cover

No	Land Cover	Bacan (ha)	Gane (ha)	Obi (ha)	Makian (ha)	Total	
						Ha	%
1	Water body	467	645	2,251	21	3,383	0.4
2	Barrier reef	0	11	0	0	11	0.0
3	Habitation	1,188	597	427	427	2,639	0.3
4	Paddy Field	0	2,204	0	0	2,204	0.3
5	Upland Field	7	0	3,290	0	3,297	0.4
6	Tree Crops	55,553	49,498	44,645	13,709	163,405	21.0
7	Open Land	26	81	36	64	207	0.0
8	Grazing Land	650	164	11,444	0	12,259	1.6
9	Shrubbery	23,479	15,035	46,545	5,024	90,082	11.6
10	Mangrove	5,806	8,864	4,568	2,107	21,345	2.7
11	Swamp	128	51	31	12	222	0.0
12	Secondary Forest	143,352	165,614	143,384	4	452,353	58.1
13	Primary Forest	0	0	27,430	0	27,430	3.5
<b>Total</b>		<b>230,656</b>	<b>242,762</b>	<b>284,052</b>	<b>21,367</b>	<b>778,837</b>	<b>100</b>

### Forest Area Status

In line with the determination of Forest and Waters Area in North Maluku Province (Utara (SK No.302/menhut-II/2013) so potential land availability to improve food crops are cultivation

land and conversion production forest. The total land area which is available is 270,074 ha (33.1% of land total area) with the least ones in Makian small island (12,714 ha) or 4,7% of the total land area (Table 7 and Picture 2b).

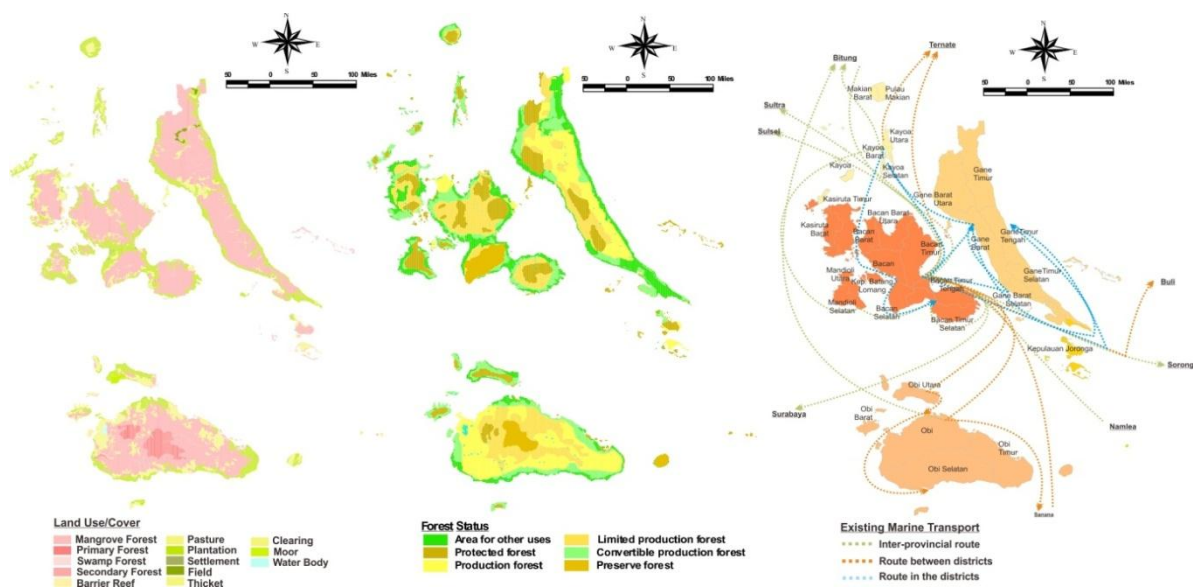


Figure 2. Map of: (a) land cover, forest status, and existing marine transport, of South Halmahera

Tabel 4. Forest Use

No	Small Island	Total Land Area	APL	HPK	HL	HP	HPT	HSA	TA
1	Obi	284,052	24,518	44,787	15,461	99,433	78,166	19,451	2,236
2	Bacan	230,656	52,351	32,995	53,379	7,018	61,794	22,673	448
3	Makian	21,367	3,679	7,895	8,339	-	1,431	-	23
4	Gane	242,762	68,480	30,682	41,197	66,503	34,697	-	1,202
<b>Jumlah</b>		<b>778,837</b>	<b>149,028</b>	<b>116,358</b>	<b>118,376</b>	<b>172,954</b>	<b>176,089</b>	<b>42,123</b>	<b>3,909</b>

Note: APL (Another Land Use), HPK (conversion production forest), HL (protected forest), HP (production forest), HPT (limited production forest), HSA (nature reserve forest), and TA (water body).

According to the land use/cover evaluation in APL so potential land availability and reserve land I for improving food crops is located on Gane, Bacan, Obi, and Makian Small Island (15,958; 12,530; and 5,225 and 202 ha). Reserve land II has big contribution in providing land to develop food crops in Makian Small Island as much as 833 ha.

### Existing Transportation

Land transportation has been built to fulfil movement needs in land use. However, transportation availability in South Halmahera tends to be for government and people economic activities. Around 46,5% of the street availability is in Bacan Island as the capital of regency (BPS, 2015). On the other hand, low accessibility is on cultivation land. Gane Timur Sub District as the central production of paddy has broken street so that farmers have difficulties in producing and distributing their production. Rice production and distribution orientation are only done for fulfilling internal and nearby area needs. Gane Timur has 603,7 ha or 27% paddy planting area of the total potential paddy field land (BPS, 2013).

Besides that, in order to connect the small islands which are relatively dispersed so port has been built. It has facilities to serve transportation route among the small islands (Ralahalu, dkk,

2013). The intensity of sea transportation route in Gane, Makian, dan Obi Island are 84, 56, 48 dan 38 trip/month. **Figure 2.**

According to the existing sea transportation system, all of small islands does not get regularly sea transportation services for instance Obi Timur, Obi Barat, Gane Timur Tengah, Gane Timur Selatan, Mandioli Selatan, Mandioli Utara, Kasiruta Barat dan Kasiruta Timur Sub Districts. In these regions, people has initiative in serving their own traditional ship. The ratio of ship ownership according to the total population in each small island is 40 people/ship in average. This ship can be used for distributing food in each small island.

### Identification of Compatibility and Priority Land Use

TPLB land use evaluation results land total of compatible (S2), incompatible (S3) as much as 217 dan 5.544,3 ha. Land limitation factors for compatible (S2) status are oxygen availability limitation factors (oa), nutrient retention (nr), nutrient availability (na), erosion hazard (eh), and land preparation (lp).

**Table 8. Compatibility and Priority Land Use**

Land Categories	Land Use Type	Land Compatibility Level	Total	
			Ha	%
Potential Land	TPLK	S2	4,042	4
		S3	2,027	2
		S2	0	0
	TPT	S3	2,024	2
		N	1,047	1
		S2	217	0
	TPLB	S3	223	0
		N	276	0
		S2	6,017	6
Reserve Land II (HPK)	TPLK	S3	16,120	16
		S2	0	0
		S3	14,469	14
	TPT	N	30,691	30
		S2	-	-
		S3	2,370	2
	TPLB	N	5,522	5
		S2	1,098	1
		S3	3,394	3
Reserve Land I (Secondary Forest)	TPT	S2	0	0
		S3	5,569	5
		N	4,852	5
	TPLB	S2	-	-
		S3	2,898	3
		N	1,107	1
		S2	-	-

with its main crops is coconut. While for 15-25% of land slope is to apply mixed farming with tree crops. Soil fertilizer obstacle needs to get land management for example calcification, organic material and fertilizer application, especially in the beginning of planting period. In order to solve long dry season, retention basin is needed related to the lack of water problem.

Total projection of optimum land use for TPLB, TPLK, and TPT can fulfil optimum land needs to land (52) 6,630.9 ha in Gane Timur Sub District (58) 5,159.2 ha. Surplus total of land availability to develop TPLB in Gane Timur Sub District is as much as 5,159.2 ha. It considers on rice field area and existing land area which does not produce, as much as 603.7 and 2,645.0 ha so that ideal land area needs is 547.7 ha. Availability of land area for optimizing TPLK and TPT development land can meet optimal land needs in South Halmahera, as much as 34,834.9 and 21,971.0 ha. However, there is deficit in fodd crops fulfillment balance from land optimize result to develop TPLK and TPT in sub district area.

Land Availability status of TPLK land potential in fulfilling ideal land needs shows variations in the same sub district. All sub district in Obi and Gane Small Islands are able to fulfil Ideal land needs for TPLK from potential land in every sub district. TPLK land potential availability in Bacan Selatan, Kayoa, Kayoa Selatan Sub Districts, and Makian Island are not able to fulfill their ideal TPLK land needs. Their own deficits are 123.9; 59.6; 8.6; dan 93.7 ha. On the other hand Bacan Selatan Sub District can fulfil its TPLK potential land availability from Bacan timur Selatan Sub District which has 1.499,9 ha. TPLK potential land availability in Makian, Kayoa dan Kayoa Selatan Island has deficit as much as 93.7; 59.6 dan 8.6 ha that can be fulfilled form that of Kayoa Utara Sub Dsictrict which has 165 ha of land availability surplus.

TPLK land compatibility evaluation also results soil fertility limitation factors and erosion hazard. It is influenced by soil cation exchange capacity, soil organic materials, nitrogen and calcium availability so that soil calcification, organic material and fertilizer application are needed. Erosion hazard can be triggered by land slope: flat (1-3%) and medium (8-15%) and open land is dominated. Furthermore, it has bad impact in decreasing soil fertility and it will cause low productivity due to nutrient and organic material loss (Pimentel and Burgess, 2013). That is why soil conservation is needed for example terrace, intercropping application, and planting according to soil contour (Widiatmaka, *et al.* 2015).

Tabel 9. Optimum Land Use According to Food Crops



Food Groups	Parameter	Small Island				Total
		Obi	Bacan	Kayoa	Gane	
Paddy Rice	Ideal Land Needs (Ha)	631.3	1,416.7	521.4	19,6	<b>547.7*</b>
	Potential Land Availability (Ha)	-	-	-	5,707.50	<b>5,707.50</b>
	Land Balance (Ha)	-	-	-	5,688.50	<b>5,159.20</b>
Upland Rice	Ideal Land Needs (Ha)	0	0	0	0	<b>0</b>
	Potential Land Availability (Ha)	3,621	1,379	82	1,196	<b>6,278</b>
	Land Balance (Ha)	3,621	1,379	82	1,196	<b>6,278</b>
Maize	Ideal Land Needs (Ha)	0	0	0	0	<b>0</b>
	Potential Land Availability (Ha)	472	180	11	156	<b>817</b>
	Land Balance (Ha)	472	180	11	156	<b>817</b>
Cassava	Ideal Land Needs (Ha)	0	0	0	0	<b>0</b>
	Potential Land Availability (Ha)	1,320	503	30	436	<b>2,289</b>
	Land Balance (Ha)	1,320	503	30	436	<b>2,289</b>
Peanut	Ideal Land Needs (Ha)	44	72	16	0	<b>131</b>
	Potential Land Availability (Ha)	1,037	395	23	343	<b>1,798</b>
	Land Balance (Ha)	993	323	8	343	<b>1,667</b>
Mug bean	Ideal Land Needs (Ha)	63	125	49	14	<b>251</b>
	Potential Land Availability (Ha)	1,433	546	51	473	<b>2,504</b>
	Land Balance (Ha)	1,370	421	3	460	<b>2,254</b>
Soybean	Ideal Land Needs (Ha)	54	110	42	17	<b>222</b>
	Potential Land Availability (Ha)	1,150	438	43	380	<b>2,012</b>
	Land Balance (Ha)	1,097	328	1	363	<b>1,790</b>
Eggplant	Ideal Land Needs (Ha)	58	126	45	55	<b>285</b>
	Potential Land Availability (Ha)	1,339	510	47	442	<b>2,339</b>
	Land Balance (Ha)	1,281	384	2	387	<b>2,054</b>
Yard long Bean	Ideal Land Needs (Ha)	46	98	36	45	<b>226</b>
	Potential Land Availability (Ha)	1,000	381	38	330	<b>1,748</b>
	Land Balance (Ha)	953	283	2	285	<b>1,522</b>
Tomato	Ideal Land Needs (Ha)	144	292	81	135	<b>651</b>
	Potential Land Availability (Ha)	3,187	1,214	84	1,053	<b>5,538</b>
	Land Balance (Ha)	3,044	922	3	918	<b>4,887</b>
Mango	Ideal Land Needs (Ha)	0	0	9.1	25.4	<b>34.5</b>
	Potential Land Availability (Ha)	217.5	7,898.5	73.5	2,842	<b>11,031.5</b>
	Land Balance (Ha)	217.5	7,898.5	64.4	2,816.6	<b>10,997</b>
Durian	Ideal Land Needs (Ha)	0	0	15.3	19.1	<b>34.4</b>
	Potential Land Availability (Ha)	121.8	4,423.2	41.2	1,591.5	<b>6,177.7</b>
	Land Balance (Ha)	121.8	4,423.2	25.9	1,572.4	<b>6,143.3</b>
Banana	Ideal Land Needs (Ha)	14.4	0	8.8	0	<b>23.2</b>
	Potential Land Availability (Ha)	95.7	3,475.4	32.3	1,250.5	<b>4,853.9</b>
	Land Balance (Ha)	81.3	3,475.4	23.5	1,250.5	<b>4,830.7</b>
Chili	Ideal Land Needs (Ha)	105	52	77	50	<b>284</b>
	Potential Land Availability (Ha)	2,622	998	78	866	<b>4,564</b>
	Land Balance (Ha)	2,517	946	1	816	<b>4,280</b>
Onion	Ideal Land Needs (Ha)	73	154	57	57	<b>340</b>
	Potential Land Availability (Ha)	1,584	603	59	523	<b>2,770</b>
	Land Balance (Ha)	1,511	449	2	467	<b>2,430</b>
Total	Ideal Land Needs (Ha)	587	1,029	401	373	<b>2,389</b>
	Potential Land Availability (Ha)	18,766	7,147	545	6,199	<b>32,657</b>
	Land Balance (Ha)	18,179	6,118	144	5,826	<b>30,267</b>

### Food Distribution and Production Optimization

Food distribution among small island needs to fulfil balance deficit on food needs fulfilment (Picture 3). This distribution is needed for rice needs fulfilment. Rice is distributed in the production centre in Gane Timur Sub District to rice storage centre in every small islands. Rice storage is done by empowering port warehouse so that rice distribution can be done with economic volume from production centre, considering rice demand frequency in each sub district is relatively low.

Then, rice distribution from storage centre to every small island is done by optimizing sea

transportations service by the ships. Transportation mode will be determined according to the demand volume in each storage place (Ralahalu, dkk, 2013).

Considering that rice field location is in Gane Island, transportation system provision that supports transportation mode integration is needed. However, it needs to be improved for rice production in South Halmahera especially for land transportation system. So that it will be easy to move the products with low transportation cost.

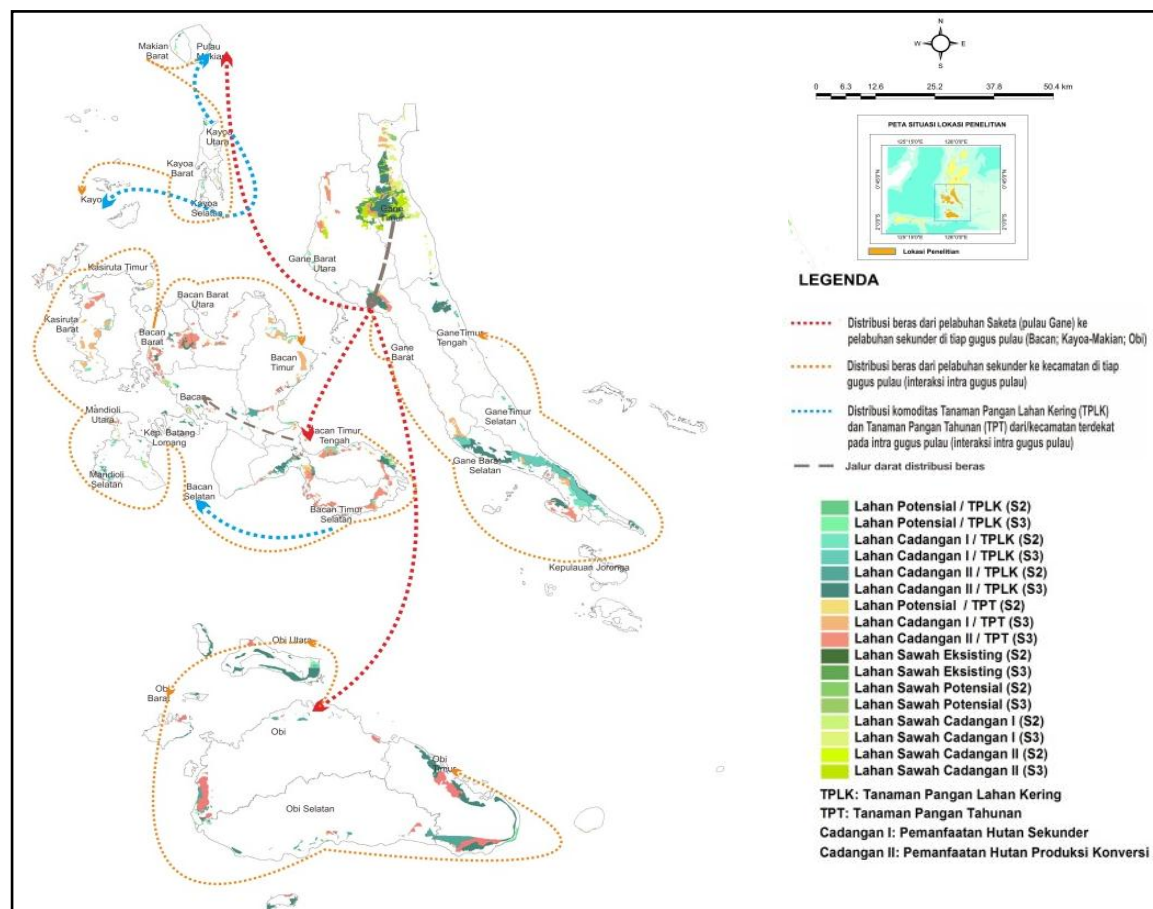


Figure 3. Food Distribution and Production Optimization

Distribution among Makian and Bacan small islands is done to cover deficit of land needs-availability balance for TPLK and TPT. Bacan Selatan, Kasiruta Timur, Kayoa, Makian Barat and Makian Island has limitation in fulfilling this so that they need food supply from any other sub districts in the same small islands. Kayoa Utara Sub District can become alternative supplier to Kayoa and Makian Barat Sub District while that of Makian island can be covered by Kayoa Barat Sub District. Bacan Island and Kasiruta Barat Sub District can be food suppliers to Kasiruta Timur

Sub District while Bacan Timur Selatan Sub District can supply food to Bacan Selatan Sub District.

### CONCLUSION

Sustainable food security development in South Halmahera can be done by production optimization approach and food distribution with small island basis to make sure affordable food availability and food access ability for people. The strategy of food production optimization concerns on land ability

and compatible in order to maintain sustainable resource utilization and ecological function as well as the ability of independently fulfilling food needs. Distribution optimization strategies are done by optimizing region production ability so that food distribution pattern which is efficient with intra and among small islands is able to be reached.

Total projection of optimum land use for TPLB, TPLK, and TPT can fulfil optimum land needs to produce 6 food crops in South Halmahera. Surplus total of land availability to develop TPLB in Gane Timur Sub District is as much as 5,159.2 ha. Availability of land area for optimizing TPLK and TPT development land can meet optimal land needs in South Halmahera, as much as 34,834.9 and 21,971.0 ha. However, there is deficit in food crops fulfilment balance from land optimize result to develop TPLK and TPT in sub district area.

Food distribution among small island needs to fulfil balance deficit on food needs fulfilment (Picture 3). This distribution is needed for rice needs fulfilment. Rice is distributed in the production centre in Gane Timur Sub District to rice storage centre in every small islands. Rice storage is done by empowering port warehouse so that rice distribution can be done with economic volume from production centre, considering rice demand frequency in each sub district is relatively low. Then, rice distribution from storage centre to every small island is done by optimizing sea transportation service by the ships. Transportation mode will be determined according to the demand volume in each storage place (Ralahalu, dkk, 2013). In this case, people ship can be used for distributing food crops in each small island.

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## REFERENCES

- Absari, U.D. 2007. Perencanaan Produksi Pangan Berdasarkan Daya Dukung Pangan Wilayah untuk Memenuhi Kebutuhan Konsumsi Pangan Penduduk di Kabupaten Nganjuk, Propinsi Jawa Timur. *Tesis*. Sekolah Pascasarjana Institut Pertanian Bogor. Bogor.
- Adrianto L. and Y. Matsuda. 2004. Study on assessing economic vulnerability of small island regions. *Environment Development and Sustainability*. **6**: 317-336.
- Arsyad, S. 2012. Konservasi Tanah dan Air. Edisi Kedua. Penerbit IPB Press. Bogor. Hal. 303-344.
- Azahari, D.H. 2008. Membangun kemandirian pangan dalam rangka meningkatkan ketahanan nasional. *J. Analisis Kebijakan Pertanian*. **6** (2): 174-195.
- Bantacut, T. 2013. Pembangunan Ketahanan Ekonomi dan Pangan Perdesaan Mandiri Berbasis Nilai Tambah. *J. Pangan Media Komunikasi dan Informasi*. **22** (2): 181-195.
- BKP (Badan Ketahanan Pangan). 2009. Food Insecurity and Vulnerability Atlas. Food Security Agency-Ministry of Agriculture. Kementerian Pertanian. Jakarta.
- BPS(Badan Pusat Statistik). 2015. Halmahera Selatan dalam Angka 2015. Badan Pusat Statistik Kabupaten Halmahera Selatan. Labuha-Maluku Utara.
- BPS(Badan Pusat Statistik). 2013. Sensus Pertanian Halmahera Selatan. Badan Pusat Statistik Kabupaten Halmahera Selatan. Labuha-Maluku Utara.
- Connell, J. 2015. Food security in the island Pacific: Is Micronesia as far away as ever ?. *Reg Environ Change*. **15**:1299–1311.
- Dahuri, R. 2008. Paradigma Baru Pembangunan Indonesia Berbasis Kelautan. IPB Press. Bogor.
- Departemen Kesehatan(Depkes). 1996. Pedoman Survei Konsumsi Gizi Tingkat Kecamatan. Ditjen Pembinaan Masyarakat. Direktorat Bina Gizi Masyarakat. Departemen Kesehatan. Jakarta.
- Djaenudin D, H. Marwan, H. Subagjo, A. Hidayat. 2003. Petunjuk Teknis Evaluasi Lahan untuk Komoditas Pertanian. Pusat Penelitian Tanah dan Agroklimat. Departemen Pertanian Republik Indonesia. Bogor
- Hardinsyah, S. Madanijah, Y. F. Baliwati. 2002. Analisis Neraca Bahan Makanan dan Pola Pangan Harapan untuk Perencanaan Ketersediaan Pangan. PSKPG-IPB dan Pusat Pengembangan Ketersediaan Pangan. Departemen Pertanian. Jakarta.
- Hay, J.E. and N. Mimura. 2013. Vulnerability, risk and adaptation assessment methods in the pacific islands region: past approaches, and considerations for the future. *Sustain Sci*. **8**: 391–405.

- Jinca, M. Y. 2009. Keterpaduan sistem jaringan antar-moda transportasi di pulau Sulawesi. *Jurnal Transportasi*. **9** (3).
- Lokollo, J. A., 2012. Kajian Model Gugus Pulau Dalam Pengembangan Wilayah Kepulauan Di Kabupaten Maluku Tenggara Barat Provinsi Maluku. *Disertasi*. Sekolah Pascasarjana. Institut Pertanian Bogor. Bogor.
- ketahanan pangan. Seminar Nasional “Kebijakan dan Aplikasi Teknologi Informasi dan Komunikasi untuk Peningkatan Daya Saing Agribisnis Indonesia. Himpunan Informatika Pertanian Indonesia-Insitut Pertanian Bogor. 6-7 Agustus 2009. Bogor.
- Pelling, M. and J.I. Uitto. 2001. Small island developing states, natural disaster vulnerability and global change. *Environmental Hazards*. **3** (2): 49-62.
- Pimentel, D. and M. Burgess. 2013. Soil Erosion Threatens Food Production. *J. Agriculture*. **3**, 443-463.
- Rachmaningsih, T. 2012. Ketahanan Pangan Di Kawasan Timur Indonesia. *Tesis*. Sekolah Pascasarjana Institut Pertanian Bogor. Bogor.
- Ralahalu, K. A., Jinca, M. Y, Siahn, L. D., dan Sihaloho, A. 2013. Pembangunan Transportasi Kepulauan di Indonesia. Brilian Internasional. Jakarta.
- Ridhwan, M.H.A., M.N. Ibrahim, F. Indawan, I. Karlina. 2012. Perdagangan Antardaerah, Distribusi, Transportasi, Dan Pengelolaan Stok Komoditas Pangan Strategis di Indonesia. Working Paper. Bank Indonesia. Jakarta.
- Manuwoto, S. dan Martianto, D. 2008. Refleksi Empat Puluh Tahun Pengembangan Panganekaragaman Pangan: Lessorns Learner and What Have To Be Done. Forum Kerja Panganekaragaman Pangan. Bogor.
- Mustafiril, B. Setiawan, Y.J. Purwanto, L.B. Prasetyo, dan D. Martianto, 2009. Pengembangan perangkat lunak optimalisasi pemanfaatan sumberdaya hayati untuk Ridhwan, M.H.A., I. Karlina, Yanfitri. 2012. Kajian pangan strategis: faktor determinasi variasi harga antar daerah. Working Paper. Bank Indonesia. Jakarta.
- Sudaryanto, T. dan I. W. Rusastra. 2008. Kebijakan strategis usaha pertanian Dalam rangka peningkatan produksi Dan pengentasan kemiskinan. *J. Litbang Pertanian*. **25**(4).
- Sumarlin. 2009. Analisis Kebutuhan Luas Lahan Pertanian Pangan dalam Pemenuhan Kebutuhan Pangan Penduduk Kabupaten Lampung Barat. *Tesis*. Bogor: Sekolah Pascasarjana Institut Pertanian Bogor.
- Survey Sosial Ekonomi Rumah Tangga Tahun (Susenas). 2014. Badan Pusat Statistik Pusat. Jakarta.
- Widiatmaka, W. Ambarwulan, A. Sutandi, K. Murtalaksono, K. Munibah and U. Daras. 2015. Suitable and available land for cashew (*Anacardium occidentale* L.) in the island of Lombok, Indonesia. *Journal of Applied Horticulture*. **17** (2): 129-139.
- Widiatmaka, Ambarwulan, W., Firmansyah, I., Munibah, K. 2014. Land suitability and dynamic system modelling to define priority areas of soybean plantation in paddy fields in karawang, west java. *Argivita*. **36**(3).

