

Land Suitability and Upland Rice Productivity With Integrated Crop Management in Sorong Regency

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ABSTRACT. The study aims to increase the productivity of upland rice in West Papua through Integrated Crop Management (ICM). This research was carried out by means of on-farm research and land surveys. Parameters observed: 1) suitability of rice land in Sorong Regency, 2) growth and production of rice plants, and 3) social and economic aspects of farmers. The results show that upland rice development can be carried out on dry land, covering an area of 317,831 ha, consisting of: very suitable land (S1) covering an area of 61,684 ha; quite suitable (S2) covering an area of 59.021 ha with land constraints in the form of nutrient retention (nr); and marginal suitable land (S3) covering an area of 197.126 ha with constraints in the form of oxygen availability (oa) and erosion hazard (eh). The yield of dry milled grain (GKG) in the ICM pattern with Situ Bagendit varieties of 4.48 t/ha and Batutegi at 4.16 t/ha was higher than the yield of GKG in the farmer pattern. The ICM pattern has a higher profit of IDR 5,360 compared to the farmer pattern of IDR 2,400 with a B/C value of 1.6 and 1.2.

Keywords: land suitability, rice productivity, ICM

INTRODUCTION

The new type of rice in particular is one of the introductory plants in both west Papua and Papua, although the absence of germplasm has been found in some areas, particularly in Merauke. Since some of the past USES, Papua's natives have begun to consume rice as one of the alternative sources of food other than the bulbs that have been consumed traditionally. To date, the demand for rice in both Papua and West Papua has been increasing over the years as the number of people turning to rice has increased.

Rice production has increased. Within a period of 5 years (2011–2015), there was an increase from 65.76 to 75.40 million tons, or an increase of 14.66% (BPS 2017). Efforts to increase the production of national rice through an additional gogo rice supply are expected to be more certain, taking sides with the poor and creating new jobs and providing added rice production. Gogo rice endeavors have positive value in supporting national food security because of the early harvest, when market rice reserves are scarce. According to Yusuf (2011), the potential development of gogo rice is found in the islands of Sumatra, Kalimantan, and Papua.

For Papua's native people, rice raising is a new matter of rice raising, but since rice is one of the food resources it offers, Papua's native people have begun to learn to grow dry rice or gogo rice. The cultivation of the gogo's system of rice on this dry land is attracting the local people because the maintenance system is relatively inequitable.

Regions of gogo rice development in west Papua are scattered from low-land dry land to highland dry land, with varying levels of productivity. The largest emission of gogo rice development in west Papua province in 2008 was found in Manokwari district, with an area of around 871 ha, followed by the 136 ha (36th) bay of star, 76th and southern sorong, 81 ha.

The production of rice obtained from gogo rice in 2008 in west Papua was 3,019 tons of GKG, or a rise of 30.3% from the previous year. as a result of the increase in harvest from 77 ha in 2007 to 1,109 ha in 2008 (BPS, 2009). while their productivity showed no significant improvement over the previous year.

One of the causes of the low productivity of gogo rice in west Papua is the result of the lack of the application of gogo rice-harvesting technology innovations, including the use of local varieties that are low in productivity and resilience to plague and disease. Based on this, the study is introduced to farmers regarding the systematic management of plants to increase the productivity and income of west Papuan rice farmers.

Materials and methods

The study was conducted on farm research in the rainy season of 2011/2012 in the sorong district of mariat. At the coordinates S 01001.940'and E 131018.865', altitude 8 mdpl. The kooperator farmer is determined to demonstrate the sample to the gogo grain farmer. The components of the technology tested are those of the technology in the ICM pattern and those of the technology in the farmer's pattern (non ICM), as at table 1.

Among the parameters observed in the study are 1) Sorong district's land suitability, 2) components of rice growth and production, and 3) the farmer's social and economic aspects (a farmer's preference and economic analysis). Growth and plant production data are analyzed using variance analysis and descriptive statistics, while social data is descriptive. Economic data is analyzed by using marginal benefit cost ratio (MBCR) analysis.

Table 1. Components of the technology applied to ICM and Gogo rice farmers' patterns in Sorong Regency.

No.	Components of the technology	ICM	farmers' patterns
1.	Pengolahan tanah	Sempurna, dibuat saluran drainase	Tanpa Olah Tanah
2.	Varietas	Batu Tegi dan Situ Bagendit	Limboto
3.	Cara tanam	Tugal	Tugal
4.	Jumlah tanaman/benih per lubang tanam	3-4 benih/lubang	3-4 benih/lubang
5.	Jarak tanam	Legowo 2:1	Tegel 25cm x 25cm
6.	Pemupukan	Urea: 250kg/ha, SP36: 100kg/ha KCl: 100kg/ha, (Pupuk Nitrogen berdasarkan BWD),	Phonska 200 kg/ha (1 kali aplikasi)
7.	Penyiangan	Pengendalian gulma terpadu	Pengendalian non PHT
8.	Pengendalian hama/penyakit	Pengendalian hama terpadu	Pengendalian non PHT
9.	Panen dan Pascapanen	Tepat waktu dan processing dengan alat dan mesin	Tepat waktu dengan cara tradisional

RESULTS and DISCUSSION

A. Characteristics of the study area

Based on the Oldeman classification system, Sorong Regency is included in zone C with a C1 classification, which is 5–6 wet months and 0–1 dry months. According to Oldeman et al. (1980), this type of climate has the potential to be planted with rice 2 times a year, where the planting of rice that falls when the rainfall is below 200 mm per month is carried out with an upland system. Oldeman's climate classification is based on the amount of water needed by plants, especially rice. The arrangement of climate types is based on the number of wet months that take place in a row.

Monthly rainfall data during the study is shown in Table 2, indicating that the rainfall during the study was quite optimal for plant growth and production, especially upland rice. Oldeman, et al. (1980) revealed that the water requirement for rice plants is 150 mm per month while for secondary crops it is 70 mm per month. Assuming that the chance of the same rain is 75%, then to meet the water needs of rice plants, 150 mm per month rainfall is required. According to Oldeman, a month is considered wet if the monthly rainfall exceeds 200 mm, and a dry month if the monthly rainfall is less than 100 mm.

Climate balance

Table 2. Monthly rainfall data during the August 2011-August 2012 assessment.

	Agt	Sep	Okt	Nov	Des	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt
	2011	2011	2011	2011	2011	2012	2012	2012	2012	2012	2012	2012	2012
Jumlah (mm)	274,4	352,2	243,0	243,0	222,8	218,8	84,7	568,0	254,8	179,1	444,4	455,6	348,4
Hari hujan	20	23	22	16	22	19	15	26	19	22	23	20	26

Source: BMKG Sorong

The climate balance describes the balance between the amount of rainfall and evapotranspiration and is expressed in surplus and deficit. The calculation of the water balance for the study area is based on the Penman-Tronthwaite method (1957). Calculations are based on a clayey texture with a water holding capacity of 300 mm/m. The rainfall data used is rainfall data at Jefmen Station, Sorong. Based on the calculation results, it shows that Sorong Regency has a surplus of water balance throughout the year without significant dry months.

The length of the rice growth period is mainly determined by the type and variety used, so that a period of 5 consecutive wet months in one year is considered optimal for one planting. If there are more than 9 wet months, then the farmer can do 2 times the planting. If there are fewer than 3 consecutive wet months, it is impossible to cultivate rice without additional irrigation.

Hydrology

Based on surface hydrological conditions, Sorong Regency is a series of Warsamson Watersheds (DAS), which flows across the Warsamson valley in the east and empties into the Sele Strait (Seram Sea). Several rivers that influence the hydrological process in Sorong Regency include: S. Warsamson, S., Klasop, S., Klasagun, S., Klabefur, and S. Bagun. The Sorong Regency, which has a relatively flat and broad topography, causes the sedimentation process in passing rivers to become more dominant, so that the rivers formed have a meander pattern.

Land Condition

Soil is a medium for growing plants; therefore, information about the quality and characteristics of the soil is very important in supporting the development of sustainable agriculture. Soil in its formation process is influenced by 5 (five) factors, namely: parent material, climate, relief, organisms (flora and fauna), and time. The quality and nature of the soil formed is strongly influenced by these five factors. The dominant soil-forming factors in Sorong Regency are the parent material and the shape of the area (Balai Tanah, 2014)

Based on land typology and field observations, it is shown that the soils in Sorong Regency are grouped into soils formed in the lowland and upland areas. Soil conditions in the two land typologies are different, so the characteristics of the soil are also different.

The condition of the sub-soil is generally flooded or often inundated (saturated with water). The parent material of the soil is alluvium and organic, and the soil characteristics are heavily influenced by water. Soils developed from alluvial material (mud, sand, and gravel) are found around and its tributaries with slightly flat to flat relief (slope 3%). Such topographical conditions cause a lot of water to be trapped or stagnate and cause the reduction process to be more dominant, so that the soil moisture regime that is formed is aquic. The soil has a slightly obstructed to very obstructed drainage. The cross section of the soil is characterized by a gray color and there are rust (mottles). Some of these soils have undergone an alteration process, characterized by increased clay and oxidation-reduction so that a cambic horizon is formed which shows gleic symptoms. Some other soils have not shown horizon development and some are still unripe.

Soils that develop from organic matter. The process of soil formation is strongly influenced by the level of decomposition of organic matter. Peat soil that is always flooded generally has a medium/moderate to mature weathering level which is characterized by organic matter decomposition at the hemic to sapric levels.

Soil in the superior area is generally dominated by leaching and deposition processes. Soil parent material comes from sedimentary material (clay, sandstone, and limestone). The nature and characteristics of the soil formed are strongly influenced by the original properties of the

parent material. Soils that develop from sandstone materials form relatively medium-textured soils with a loose, moist consistency.

Land suitability results

The physical land suitability class of each commodity in each agro-ecological unit is grouped by class and subclass. Land suitability classification is divided into 4 classes, namely: very suitable (S1), quite suitable (S2), marginally suitable (S3), and not suitable (N). At the subclass level, limiting/inhibiting factors for plant growth are listed, written with symbols placed after the symbol for the land suitability class. For example, S2oa, i.e., the land is quite suitable for the limiting factor/inhibiting the availability of oxygen (drainage).

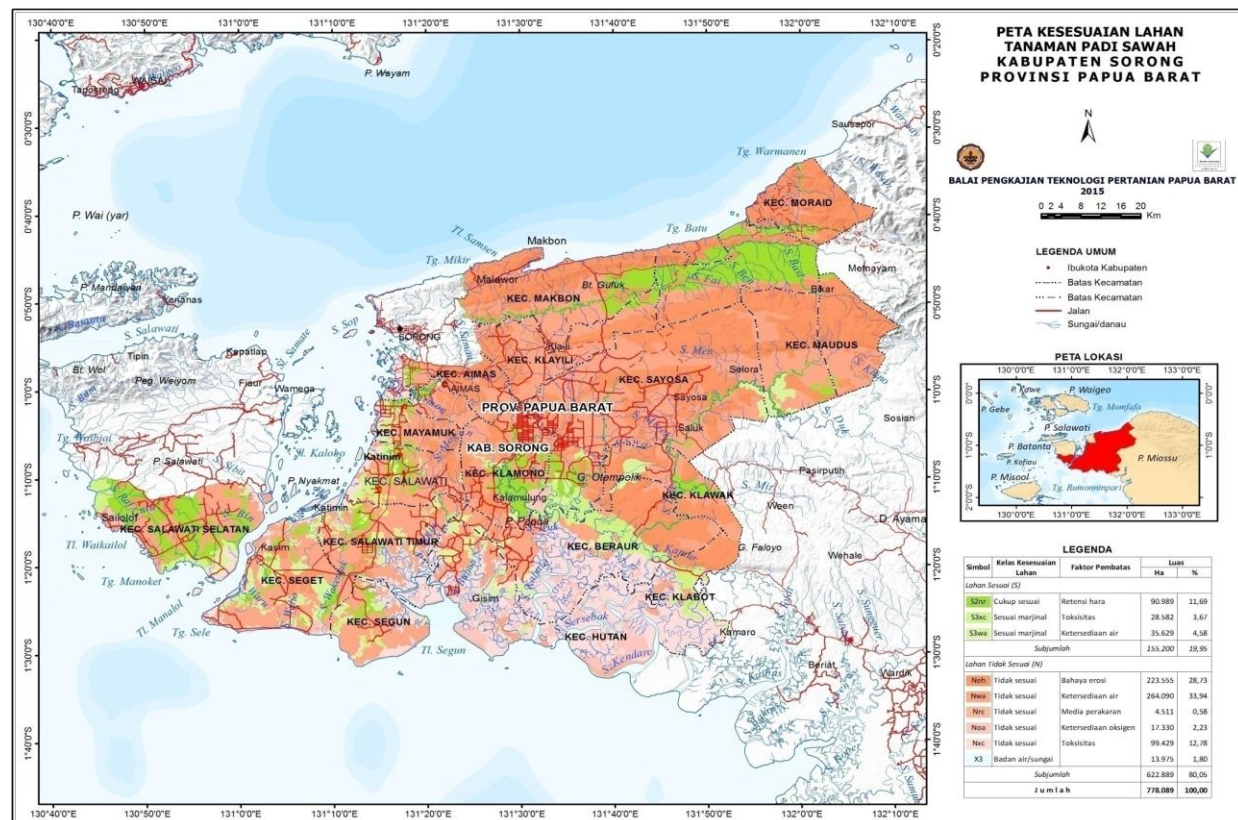


Figure 1. Map of rice land suitability in Sorong Regency (BPTP Papua Barat, 2015)

From the results of the land suitability evaluation of several commodities, it shows that the land that can be developed for agricultural commodities in Sorong Regency is 468,202ha (60.17%), while the remaining 309,887ha (39.83%) cannot be developed for agriculture due to the biophysical conditions of the land. It is not possible. If these lands are forced to be developed for agriculture, it is very possible that land degradation and environmental damage will occur. Therefore, the land is designated as a conservation area.

Lowland rice development can be carried out in wetlands, covering an area of 155,200 ha (19.95%) consisting of: moderately suitable land (S2) covering an area of 90,989 ha (11.69%) with land constraints in the form of nutrient retention (nr); and marginal land (S3) of 64,211 ha (8.25%) with constraints in the form of water availability (wa) and toxicity (xc). This land has the potential to be developed for wetland food crops (rice fields). The development of lowland

rice in this area can be done twice a year. While the land that is not suitable for the development of lowland rice is 622,889 ha (80.05%). This land has very heavy constraints, namely in the form of erosion hazard due to a rather steep slope (>15%), oxygen availability because the land is always inundated continuously, root media due to sandy soil texture, water availability due to no water source, and toxicity due to the presence of materials. sulphidic acid on the soil surface. Details of land suitability for lowland rice development in Sorong Regency are presented in Table 3.

Table 3. Land suitability class for lowland rice.

Simbol	land suitability class	Limiting Factor	land area	
			Ha	%
Lahan Sesuai (S)			90.989	11,69
S2nr	Cukup sesuai	Retensi hara		
S3xs	Sesuai marjinal	Toksisitas		
S3wa	Sesuai marjinal	Ketersediaan air		
Subjumlah			155.200	19,95
Lahan Tidak Sesuai (N)			223.555	28,73
Neh	Tidak sesuai	Bahaya erosi		
Nwa	Tidak sesuai	Ketersediaan air		
Nrc	Tidak sesuai	Media perakaran		
Noa	Tidak sesuai	Ketersediaan oksigen		
Nxc	Tidak sesuai	Toksisitas		
X3	Badan air/sungai			
Subjumlah				
J u m l a h			778.089	100,00

Table 4. Classification of upland rice land suitability.

Simbol	land suitability class	Limiting Factor	land area	
			Ha	%
Lahan Sesuai (S)			1.684 9.021 143.385 53.742	7,93 7,59 18,43 6,91
S1	Sangat sesuai	-		
S2nr	Cukup sesuai	Retensi hara		
S3eh	Sesuai marjinal	Bahaya erosi		
S3oa	Sesuai marjinal	Ketersediaan oksigen		
Subjumlah			317.831	40,85
Lahan Tidak Sesuai (N)			223.555 218.218 4.511 13.975	28,73 28,05 0,58 1,80
Neh	Tidak sesuai	Bahaya erosi		
Noa	Tidak sesuai	Ketersediaan oksigen		
Nrc	Tidak sesuai	Media perakaran		
X3	Badan air/sungai			
Subjumlah			460.258	59,15
J u m l a h			778.089	100,00

Upland rice development can be carried out on dry land, covering an area of 317,831ha (40.85%) consisting of: very suitable land (S1) covering an area of 61,684 ha (7.93%); quite suitable (S2) covering an area of 59,021 ha (7.59%) with land constraints in the form of nutrient retention (nr); and marginally suitable land (S3) covering an area of 197,126 ha (25.33%) with constraints in the form of oxygen availability (oa) and hazards erosion (uh). Suitable land occupies flat to undulating slopes (slope 15%). Upland rice development can be carried out during the rainy season. Meanwhile, the land that is not suitable for maize development is 460,258 ha (59.15%). This land has very heavy constraints, namely in the form of erosion hazard due to steep slopes; availability of oxygen, because the land is always inundated continuously; and root media due to sandy soil texture. Details of the results of land suitability for upland rice development in Sorong Regency are presented in Table 4.

B. Components of plant growth

Table 5 shows that the average plant height at the age of 30 days after planting in the ICM pattern was higher than in the farmer pattern. The Situ Bagendit variety and the Bartutegi variety in the ICM pattern were on average higher than the Limboto variety grown with the farmer pattern, which was 38.53 cm with a higher standard deviation of 6.18 cm. This shows that the growth of the Limboto variety planted with a farmer's pattern results in more diverse plant growth.

The diversity of plant height at 45 HST and at harvest time in the ICM pattern shown by the two varieties, namely Situ Bagendit and Batutegi varieties, was more uniform than the appearance of plant height in the farmer pattern shown by the Limboto variety. The standard deviation of plant height at harvest for the Situ Bagendit and Batutegi varieties in the ICM pattern was 2.27 cm and 4.25 cm, respectively, while the standard deviation of plant height for the Limboto variety in the farmer pattern was 6.32 cm.

Table 5. Shows the growth of upland rice on the ICM and MH farmer patterns. 2011-2012 in Sorong Regency.

Pattern/Variety	Plant height 30 HST (Cm)	Plant height 45 HST (Cm)	Plant Height When Harvested (Cm)	Number of tillers Productive
PTT				
Situ Bagendit	40,76 ± 1,68	70,92 ± 1,79	99,92 ± 2,27	20,40 ± 3,95
Batutegi	45,04 ± 2,83	85,41 ± 1,42	127,88 ± 4,25	13,60 ± 3,03
Pola Petani				
Limboto	38,53 ± 6,18	80,08 ± 9,90	111,63 ± 6,32	12,00 ± 1,89

Note : Mean ± standard deviation (n=10)

In general, it shows that the ICM pattern of plant height growth is more uniform than the farmer's pattern. The variety of plant heights in the farmer's pattern is one result of the lack of land preparation and arrangement of drainage channels and the presence of weed pressure. This results in non-uniform plant growth and stress.

Components of plant production

Based on the results of observations of plant production components in Table 6, it shows that the highest number of panicles was obtained in the Situ Bagendit variety and the Batutegi variety in the ICM pattern, namely 21.8 and 12.5, respectively. Meanwhile, the lowest tiller was obtained in the Limboto variety on the farmer pattern, namely 10.9 tillers with a standard deviation of 2.28. Meanwhile, the longest panicle with the lowest standard deviation was found in the Batutegi variety, which was 28.57 cm with a standard deviation of 0.92 cm, followed by the Limboto variety in the farmer pattern with a panicle length of 26.85 cm. However, the

standard deviation was higher than the Situ Bagendit and Situ Bagendit varieties. Batutegi on the ICM pattern.

Table 6. Components of upland rice production and yield on the ICM pattern and the MH farmer pattern are shown in Table 6. 2011-2012 in Sorong Regency

Pattern/Variety	The quantity of panicles / clump	panicle length (Cm)	Grain Filling Percentage / malai (%)	Results GKG (Ton/Ha)
ICM				
Situ Bagendit	21,8 ± 2,97	26,60 ± 1,19	97,15	4,48
Batutegi	12,5 ± 1,84	28,57 ± 0,92	65,79	4,16
farmer pattern				
Limboto	10,9 ± 2,28	26,85 ± 1,42	83,70	3,52

Keterangan : Rata-rata ± standar deviasi (n=10)

The highest percentage of grain content was obtained in the Situ Bagendit variety on the ICM pattern, which was 97.15%, followed by the Limboto variety on the farmer pattern. Meanwhile, the lowest percentage of unhulled grain was obtained in the Batutegi variety in the ICM pattern, which was 65.79%. One of the causes of the low percentage of filled grain in the Batutegi variety is the high attack of stem borer, which reached 37.6% and walang sangit as shown in Table 5. The attack of these two pests will result in high empty grain or a low percentage of filled grain. The highest yield of dry milled grain (GKG) was obtained in Situ Bagendit and Batutegi varieties with ICM patterns of 4.48 t/ha and 4.16 t/ha, respectively.

C. Farming Evaluation

The cost of rice farming in the ICM pattern is lower than in the farmer pattern. This difference is mainly due to the use of fertilizer production facilities and herbicides. In the pattern of farmers, the use of fertilizers and herbicides is inefficient and effective because they generally do not follow fertilizer recommendations and the use of appropriate herbicides. In addition, the use of labor in the farmer's pattern is also inefficient.

The introduction of several components of technological innovation in the ICM pattern resulted in higher upland rice yields compared to the farmer pattern. This, of course, will affect the income and profits that will be received by farmers. The results of the B/C analysis obtained a value of 1.6 for ICM and 1.2 for the farmer pattern method. This value indicates that for every IDR 100, the costs incurred in the form of inputs will be able to provide a revenue reward of IDR 160 for the ICM pattern and IDR 120 for the farmer pattern (Table 6).

The results of the MBCR analysis show that the ICM pattern is superior to the farmer pattern, which is 0.32. This indicates that soybean ICM is feasible to replace soybean farming patterns developed by farmers because the MBCR value is >2. According to Malian (2004), if the MBCR value is 2, then the farm is feasible and interesting to develop.

Table 6. Analysis of upland rice farming on the PTT Pattern and the MH Farmer Pattern Sorong Regency in 2011/2012

Description	ICM	farmer pattern
Hasil (kg/ha)	4160	3520
Penerimaan (Rp/ha)	14.560.000	12.320.000
Sarana Produksi (Rp/ha)	2.680.000	3.050.000
Tenaga Kerja (Rp/ha)	6.520.000	6.870.000
Total Biaya Produksi (Rp/ha)	9.200.000	9.920.000
Keuntungan (Rp/ha)	5.360.000	2.400.000
B/C Ratio	1.6	1.2

MBCR	0.32	
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CONCLUSION

Based on the results of the assessment in the field, it can be concluded as follows:

1. Development of upland rice can be carried out on dry land, covering an area of 317,831 ha (40.85%), consisting of: very suitable land (S1) covering an area of 61,684 ha (7.93%); quite suitable (S2) covering an area of 59,021 ha (7.59%) with land constraints in the form of nutrient retention (nr); and marginally suitable land (S3) covering an area of 197,126 ha (25.33%) with constraints in the form of oxygen availability (oa) and hazards erosion (uh).
2. The yield of dry milled grain (GKG) in the ICM pattern with Situ Bagendit and Batutegi varieties was higher than the GKG yield in the farmer pattern, with respectively 4.48 t/ha and 4.16 t/ha. Meanwhile, the yield of dry milled grain obtained from the farmer pattern with the Limboto variety was only 3.52 t/ha.
3. The benefits obtained in both upland rice farming patterns are all profitable and financially feasible, but the ICM pattern is more profitable, namely Rp. 5,360,000 while the farmer's pattern is Rp. 2.4 million with a B/C value of 1.6 and 1, respectively. ,2.
4. The MBCR value is 0.32, indicating that the ICM pattern for upland rice in Sorong district is economically feasible and attractive to develop.

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Thank-you note

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