Land Characteristic and Land Availability for Food Crops to Attain Food Sovereignty in Kabupaten Bandung

Abraham Suriadikusumah

Dept. of Soil Science, Faculty of Agriculture, Universitas Padjadjaran
Jl. Raya Bandung Sumedang Km 21 Jatinangor

Korespondensi: abraham@unpad.ac.id

ABSTRACT

Land use change has long been a problem in West Java, especially in Bandung district (Kabupaten Bandung), a hinterland and buffer area for the Bandung Metropolitan and one of the major crop district in West Java province. Land use conversion caused the decrease of soil productivity and land availability for agricultural activity especially for food crops, the land reduction is unable to compensate the need of food availability.The research in this study has been done by using descriptive and comparative survey method to study land characteristic and status of land availability in Kabupaten Bandung and its contribution food crop development. The results showed that soil fertility status in Bandung district varies from very low to high. Soil pH conditions ranged from acid to neutral. The actual availability of land for food crops currently stands at 52,790 hectares, with paddy fields as current land use. Availability of potential land for food crops are 64,970 hectares with the current type of land use in the form of bushes and plantations.

Keywords: *characteristics, availability, land use conversion, land, district Bandung*

1. INTRODUCTION

Land use conversion has been a problem especially in West Java. The decline in rice production in West Java, which provides 17.84 percent of the national rice production, is due to the shrinking of paddy fields from land conversion and the slacking productivity in areas of intensification in the region (Development Planning Agency at Sub-National Level of West Java Province, 2009). Kabupaten Bandung is a part of Bandung metropolitan development area, a hinterland and buffer area of Bandung city and one of the districts that have sufficient food security.

Development of Bandung city has shifted the conomical activity of Kab Bandung. Distribution of agricultural land in Kabupaten Bandung during 2004-2011 is 1,898.32 ha, consisted mainly of paddy fields. The largest land use change occurred in Kabupaten Ciparay of 195.23 ha, Ciwidey 176.47 ha, followed by Pacet of 152.93 Ha, Banjaran 150.03 Ha, Rancaekek of 126.43 ha, Cileunyi of 117.41 ha, Soreang of 112.98 Ha and Bojongsoang of 112.56 ha. While the smallest function of agricultural land is Cimenyan sub-district of 4.51 Ha.

One of the factors that encourage the conversion of agricultural land is the growth of the population. In the period of 2011 – 2012, the population increased, therefore resulted in the increase of agricultural land conversion by 6.5% in 2012 (Regional Development Work Plan of Bandung District, 2014). Compared to the population growth, economic growth increased by 6.15% during the period 2011-2012, this economic growth may be related to the land conversion in 2012.

The increase did not match with the level of land productivity rice fields. In 2011 until 2015 Bandung district, especially Baleendah, Ciparay, Pacet sub-district and surrounding areas experienced floos and rodent attack, hence the productivity of paddy fields decreased.The conversion of rice fields to residential, commercial and industrial area influenced the availability of land for agricultural production, causing the imbalance between stock and demand.

Food availability is related to food supply through production, distribution, and exchange. Food production is determined by a variety of factors, including land ownership and use; type and soil management; selection, breeding, and management of agricultural crops; breeding and management of livestock; and harvesting. Land use, water, and energy to grow food often compete with other needs.

Land use for agriculture may be transformed into settlements or lost due to desertification, salinization, and soil erosion due to unsustainable agricultural practices. Consequently, the current and most difficult challenges to face are land issues caused by the declining level of soil fertility (Atmojo, 2006) land conversion and land area. Decrease in fertility or degradation rates other than due to over-functioning is also caused by water erosion and wind erosion, chemical degradation and physical degradation (Eswaran et al., 2001, Dariah et al., 2004), fragipan, lateritic / plintit formation, soil cultivation, intensive land use, (Haridjaja, 2008; Las et al., 2006). Land degradation rates depend on the speed of land degradation, land use, duration of land use, and management practice (Acharya and Kafle, 2009).

The development and management of the land should take into account is the basic characteristics of the soil capability that able to mitigate the impact of changes in ecosystem services or land critical degree. According to Purwowidodo (1983), the land has a description was a physical environment that includes climate, soil relief, hydrology, and plant that to some extent will affect the ability of land use. Understanding of soil characteristics can be done with soil mapping, in addition to the determination of soil classification as well as to assess the degree of capability or ability of a land (Sarief, 1986). Therefore, the estimation of soil properties associated with potential land use and its response to management is very important (Abdullah, 1993).

Based on the description, several problems that need to be studied and solved is to know the land characteristic status and land availability in Kabupaten Bandung to fulfill and contribute to the development of food crop. This research is expected to provide input to the local government of West Java Province in the form of data and information to what extent the condition of soil characteristics, especially soil fertility status and the area of production land for crop agriculture can be optimized.

The geological conditions of Kabupaten Bandung are based on Silitonga (1973) and Alzwar, et al., (1992), composed of volcanic rocks, sedimentary rocks, intrusion rocks, lake sediments and alluvium deposits. Volcanic rocks are generally aged quaternary and composed of volcanic breccia, tuff, lava, sediment lava which occupies the morphology of the hills to the mountains. These volcanic rocks are generally scattered in the northern, central and southern parts of Kabupaten Bandung. Miocene sedimentary rocks are generally in the form of sandstone, claystone, limestone, limestone and breccia/ conglomerate.

Sedimentary rock spread in the southern part of Kabupaten Bandung occupies the morphology of the hilly to mountains. Pleistocene age of intrusion rocks in the region of Bandung District in the form of igneous andesite rocks that form several mountains or hills that are spread unevenly in various areas of Kabupaten Bandung. The sediment of Bandung lake is composed of a semi-solid (sediment), sandy, silt or clay material as the deposition of the material at the bottom of the lake with a younger age. Sediment lake is spread in the morphology of flat in the middle of Bandung district which is currently widely used for residential and industrial areas. While alluvium deposits are generally composed of loose-sized materials (boulder), gravel, gravel to fine sand as a river sediment product and spread around the rivers.

Morphology of Kabupaten Bandung is divided into zones of flat and hills. The flat Zone is located in the northern part with the elevations of 500 to 1000 meters above the sea level and geologically composed of sedimentary volcanoes in Quarterage. This zone is composed of slopes ranging from zero to eight degrees. The other is the hilly zone, located in the southern part of Bandung district. This zone has an elevation of 1000 - 2500 msl and is geologically composed of rocks with volcanic genesis. This zone is composed of slopes with a slope of eight to thirty five degrees.

Based on the topographic profile analysis of the south-north transverse from Kecamatan (sub-district) Pangalengan to Cilengkrang, it is seen that the southern area of Kabupaten Bandung (Kecamatan Pangalengan and Kertasari) is dominated by undulating to flant and steep slopes (hilly to mountainous) in the center (Kecamatan Pacet until Arjasari). While in the middle region (Kecamatan Ciparay, Majalaya, Rancaekek, and Cileunyi) are relatively flat and steep back in the northern region (Kecamatan Cilengkrang and Cimenyan). The topography of the land in the west (Kecamatan Ciwidey,, Rancabali, Pasir Jambu) to the middle (Kecamatan Pacet) is relatively steep and flat on the east (Kecamatan Majalaya and Cicalengka).

2. MATERIALS AND METHODS

2.1 Materials

Data analysis was performed on laboratorial result of soil physical and chemical properties such as soil texture, C-organic, soil pH, base saturation (kejenuhan basa/KB) and other soil macronutrients. Land use is done through satellite image interpretation which later ground-checked to verify interpretation result. The slope of the field slope was observed by a clinometer tool post calculation from the contour line density in the topographic map. Soil type analysis referred to the Soil Survey Division Staff (1993) soil taxonomy were given up to sub-group level in accordance to Soil Taxonomy (Soil Survey Staff, 2006).

Population density data were used to develop a population density map of urban and rural settlements. Residents of rural and urban settlements wete distinguished based Landsat 2010 interpretation. The morphology, slope, and hydrological conditions in Bandung District were analyzed using G-DEM Aster image data. Image digitization was performed by GIS-based software such as Global Mapper 15 and MapInfo.

Analysis of land availability was divided into actual and potential level. The actual land availability was based on data from the Agriculture Department and Landsat Image 2016 analysis, while potential land availability was based on RBI map, Forest and Water Status Status Map, Space Pattern Map and Space Structure Map. Available land for agriculture was land with APL area status and land use for cultivation (RTRW Map).

2.2 Methods

The research was conducted by using descriptive and comparative survey method. Comparative study was conducted on unit of land in the form of images (maps and satellite images) and tabulation data resulting from overlay of several maps and secondary data consisting of 1: 25.000 scale earth map, geology scale 1: 100.000, topography scale 1: 100.000. Land use results were obtain through the interpretation of satellite imagery, rainfall data, slope, population.

A field descriptive survey was conducted to obtain soil characteristics data through stratified purposive soil sampling, based on the physiographic approach with landform as the observation determination base. Obtained data are land use, slope, and soil type. Observation of soil type was done through the description of soil profile and drilling. Horizons of each soil profile was taken for laboratory analysis. Disturbed soil samples were taken as composite samples, and

undisturbed samples were taken by ring sampler.

3. RESULTS AND DISCUSSION

3.1 Result

Based on the topographic data in Table 1, there are 5 classes of land slope in Bandung District that are class A (0-3%), B (3-8%), C (8-15%), D (15-25%) and E (25-45%). The amount of land slope class (slope class) in Kabupaten Bandung is almost equivalent for all classes with the widest distribution at 15-30% slope of 25.55% and the smallest area at 30-45% slope of 14.3%.

Table 1 Topographic data result of DEM analysis

No.	Symbol	Slope Class	Area	
			Ha	%
1	A	0-3%	33,542.57	19.43
2	B	3-8%	37,031.75	21.45
3	C	8-15%	33,290.84	19.28
4	D	15-30%	44,108.60	25.55
5	E	30-45%	24,689.53	14.30

Rainfall in Bandung district ranged from 2,700-3,900 mm/year Based on data from BMKG (Bureau of Meteorology, Climatology, and Geophysics) Kabupaten Bandung in 2015 with 40 point weather station. Based on GIS interpolation, the location with the highest rainfall is in the southern part of Kabupaten Bandung, with the rainfall range of 3,500-4,000 mm/year, while the location with the lowest rainfall is in the north of Kabupaten Bandung.

Land use in Kabupaten Bandung obtained from ALOS image processing in 2015 revealed nine use classes: primary forest, secondary forest, plantation, field/moor, paddy, bushy wood, river/lake/reservoir/situ, pond, building/settlement. The dominant use of cultivation and paddy fields is in the middle to the north, this is because one of them is supported by a flat to rolling slope factor, thus allows farming in the area. Southern Kabupaten Bandung is dominated by forest and plantations with steep until very steep slopes.

Soil types in Kabupaten Bandung is divided into seven major land classifications based on FAO: Regosol, Andosol, Grumusol, Mediteran, red-yellowist podsolic and red yellow podzolic; and three soil order based on USDA classification: Andosol, Inceptisol, and Entisol. Based on field observation, the dominant soil type is Geisol Eutrik (Typic Endoaquepts) with the land cover in the form of rice field and secondary crop (palawija).

Table 2 Soil type and its extent in Bandung district

No.	Soil Order	Soil type		Area	
		BBSDLP	USDA	Ha	%
1	Andosol	Andosol Eutrik	Typic Hapludands	54,249.04	31.42
2		Andosol Gleik	Aquic Hapludands	5,105.46	2.96
3		Andosol Litik	Lithic Hapludands	1,634.31	0.95
4		Andosol Melanik	Typic Melanudands	9,021.08	5.22
5		Gleisol Eutrik	Typic Endoaquepts	47,224.23	27.35
6		Cambisol Distrik	Typic Dystrudepts	7,410.08	4.29
7	Inceptisol	Cambisol Eutrik	Tyoic Eutrudepts	46,659.54	27.02
8		Cambisol Litik	Lithic Dystrudepts	752.05	0.44
9		Latosol Kromik	Typic Dystrudepts	25.45	0.01
10	Entisol	Arenosol	Typic Udhortents	341.94	0.20

Gleisol Eutrik is a dominant soil type in northern part of Kabupaten Bandung. Dominant soil types in Kabupaten Bandung are Andosol Eutric (31%), followed by Gleisol Eutrik (27%) and Cambisol Eutrik (27%) (Table 2). The color of the soil are mostly dark (dark brown - gley) with Hue 2.5 YR to 10 YR, and Chroma value of 1-6, with the most common color 7.5 YR 3/3. Andisols is generally dark in the upper layer, high organic matter content, low bulk density, high porosity, high phosphate retention (Shoji et al., 1993).

Based on chemical analysis, the fertility status of Kabupaten Bandung soil varies from very low to high. The soil pH values were found to be between 4.5 to 7.0 (low to high) with the average pH of topsoil layer of 5.3 (low), whereas the mean pH values between layers showed no significant result ranged from 5.26 to 5.31 (low).

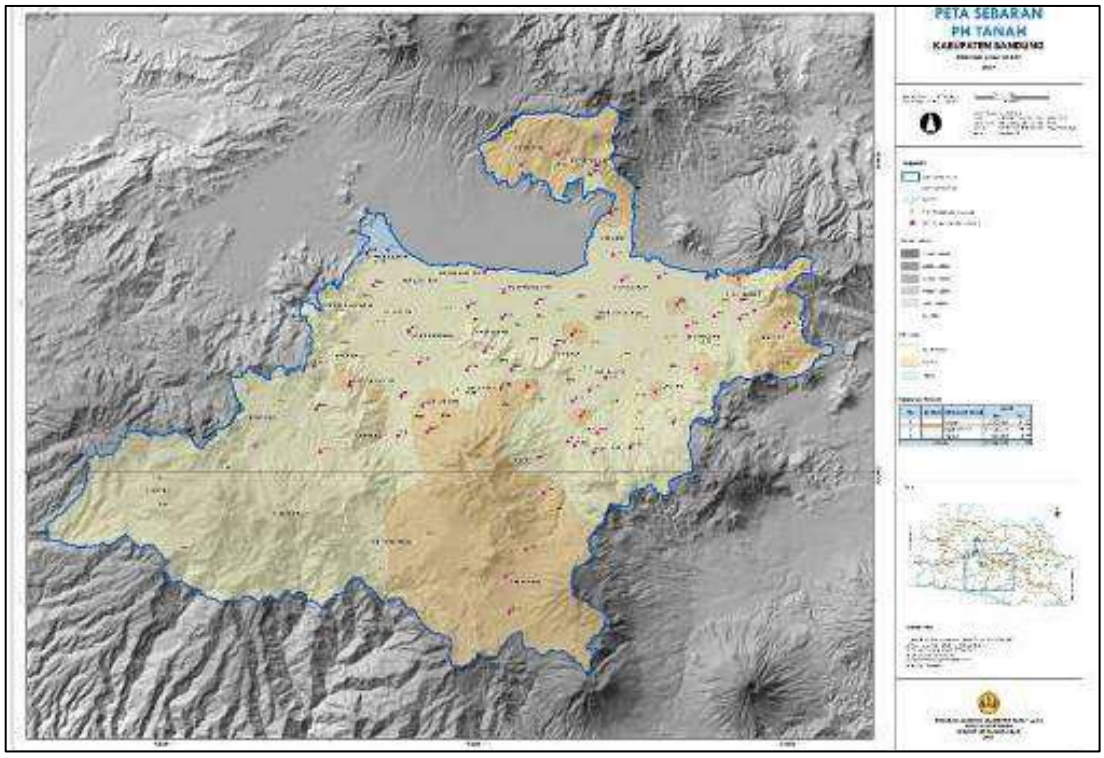

Figure 1 Soil pH distribution in Kabupaten Bandung

The land availability for food crops is divided into actual and potential land availability. Figure 2 shows the actual availability (dark green) and potential availability (light green) for food crops cultivation (tolong dikonfirmasi dulu karena keterangan di peta kurang jelas). Potential land consists of shrubs and plantations.

3.2 Discussion

The intensive rocks weathering process in Kabupaten Bandung district produce thick and fertile soil layers. Chemical and physical weathering leads to the breakdown of various mineral constituents due to the tropical conditions of this region. High rainfall, deep root penetration of forest plants, and mineral properties that are easily weathered, especially from sedimentary rocks resulted in loose, fertile, and easily eroded soils that can provide various nutrient needed by plants. Due to soil characteristics, Kabupaten Bandung became a potential area for agriculture, plantation, and forestry area.

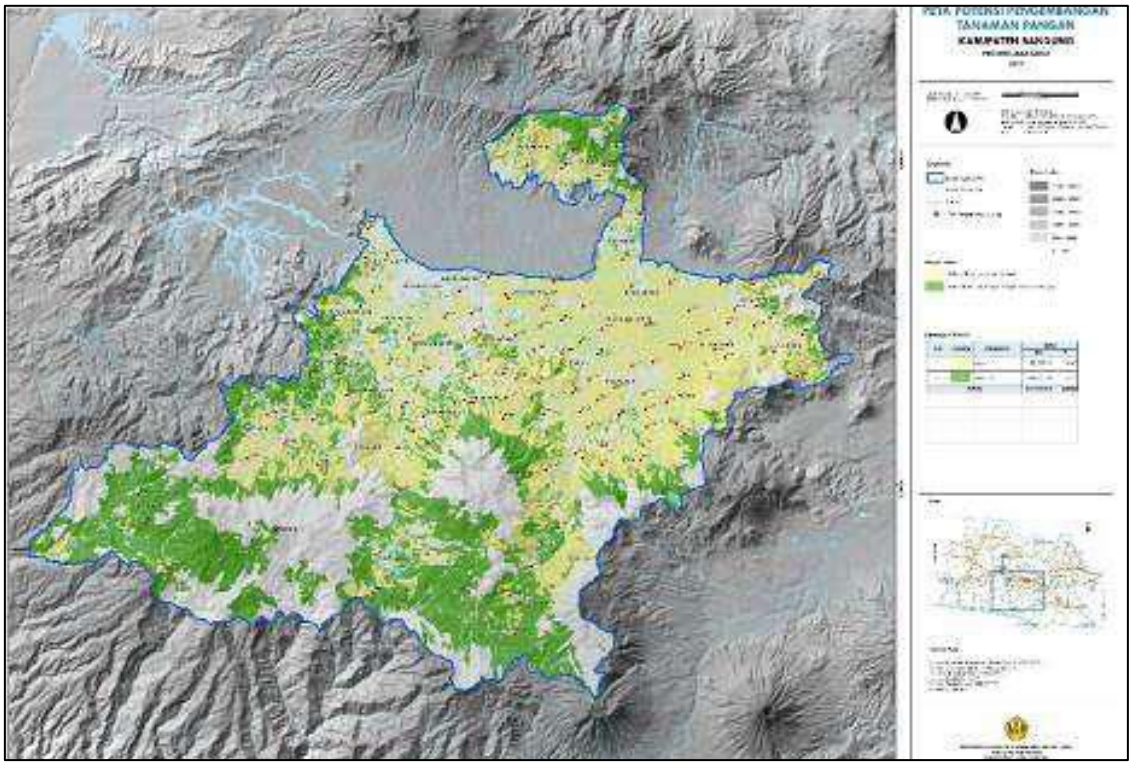

Figure 4 Actual and Potential land availability in Kabupaten Bandung

The Andosol Eutrik / Typic Hapludands is soil with andik properties such as deep solum, good drainage, slightly acid pH, medium soil texture and has a high base saturation. This soil type can be found at old volcanic hillside landforms, middle and upper volcanic slopes with andesite/basalt and tuffs. Andosol Gleik/Aquic Hapludands is a soil with andik properties: deep solum, drainage somewhat obstructed, slightly acid pH, medium soil texture and has a high base saturation. Andosol Gleik/Aquic Hapludands can be found in central volcanic slope landform with andesite/basalt and tuff material.

Andosol Litik/Lithic Hapludands is a soil type with shallow solum, good drainage, slightly acid pH, medium soil texture and have high base saturation. Found on a conical landform with parent material of andesite/basalt and tuffs. Andosol Melanic/Typic Melanudands are soils with soil properties of the soil at all their thickness, damp and chromatic values of 2 or less (dark), organic carbon content of 6% or more as weighted average and organic carbon content of 4% or more in all layers, have deep solum, good drainage, slightly acid pH, medium soil texture and have high base saturation. Found on a central volcanic slope landform with andesite/basalt and tuff material.

Gleisol Eutrics/Typic Endoaquepts are always flooded soil due to being in lowland and or basin having deep solum, obstructed drainage, fine texture, slightly acid pH and high base saturation. Found in floodplains landform, colluvial plains, lacustrine basins and old volcanic plains with colluvium precipitate parent material, clay deposits, mud and sand, breccia, andesite, and basalt. District Cambisol/Typic Dystrudepts has a cambik horizon with deep solum, good drainage, fine texture, acid pH and low base saturation. Found on old volcanic mountain landforms with breccia and andesitic materials.

Cambisol Eutrik/Typic Eutrudepts has a cambik horizon with deep solum, good drainage, fine texture, slightly acid pH and

high base saturation. Found on old volcanic plain landforms, lower volcanic slopes, old volcanic hills, volcanic legs and old volcanic mountains with breccia, andesite, basalt, and tuffs. Cambisol Litik/Lithic Dystrudepts has a Kambic horizon with shallow solum, good drainage, medium texture, acid pH and high birth weight. It is found on a conical landform with a parent breccia, andesite, and basalt.

Chromic Latosol/Typic Dystrudepts has a chromix horizon with deep solum, good drainage, fine texture, acid pH and low base saturation. Found on volcanic intrusion ground form with dacitic parent material. Arenosol/Typic Udorthents is a sand-dominated soil with little organic material with medium solum, relatively quick drainage, slightly coarse texture, high base saturation. Found on the cassava ground landform with andesite/basalt and tuff parent material.

The physical characteristic of topsoil texture based on Soil Survey Division Staff (1993) is silty clay or SiC (32 points), clay/C (26 points) and silt clay loam/SiCL (22 points). Silty clay and silt clay loam formed in the upper slopes, whereas clay texture is found in valleys and basins. Soils of fine texture (dominant clay) are generally cohesive and difficult to crush and sand fractionation soils with larger sizes than dust and clay are more resistant to erosion since soils dominated by sand fractions have high infiltration and permeability capacities and also low of sensitivity (Meyer and Harmon, 1984).

The permeability of soil in the study location is divided into obstructed, moderate and rapid. Inhibited permeability found in valleys or inoculated sites (Gleisol Eutrin and Andosol Gleik), whereas moderate soil permeability located on the central or upper slopes (Cambisol Eutrik, Cambisol Distrik, Andosol Eutrik and Andosol Melanic), whereas rapid permeability found in rocky areas (Litik). Intensive soil management without resting the soil and without the addition of organic matter resulted in damage to soil structure resulting in decreasing soil permeability (Arifin, 2010).

In Figure 1, the most widely available pH distribution is slightly acid pH. slightly acidic pH is found in almost every landform, from mountains to flat with tuff volcanic, basalt and andesite and colluvium deposits, especially in the south-west and central Kabupaten Bandung. Similar with slightly acid pH, acid pH is found almost on every landform in the middle to the south of Kabupaten Bandung. While neutral pH is found in small extents in the north-west area with lime parent rock material.

Very low to low C-organic is found in most intensive farming areas as well as land with Cambisol soil types (Figure 2). While medium to high C-organic found in old volcanic mountain areas with the type of land use in the form of tea plantations, shrubs, and forest with the dominance of soil type of land Andosol. Monde et al. (2008) stated that forest land has high organic content because of the supply of forest vegetation. But on the other hand, on farm decomposition process takes place quickly because of faulty farm management and land opening through arsonry, which result in increasing soil temperature.

The content of organic matter on cultivated land generally decreased (Yusrial, et al., 2004). Firmansyah (2003) said that cultivated land compared to non-degraded the content of organic matter was 38% lower, and 55% of the bases were exchangeable. In addition, pH tends to be lower especially in mineral soils. Total nitrogen levels are in the range of low to medium with the dominance of low total nitrogen content. Low nitrogen levels are found on all landforms. Total phosphate soil levels ranged from very low to very high. Very low total P levels are found in Cambisol soil types with hilly and mountainous landforms. Low to moderate total-P levels were found in intensive agricultural areas. While the levels of total-P were high to very high in areas with Melamik

Andosol soil type with high phosphate retention rate.

Based on the overlay result on morphology, topography, hydrology, climate and land characteristics, the agro-ecological zone of Kabupaten Bandung is included in zone IV. This zone is a zone with directed land use for dryland agriculture and lowland horticultural crops (Suriadikusumah and Herdiansyah, 2014). Referring to the national agricultural program, relatively flat land is directed to food crops as an attempt to strengthen national food security. Ecological commodities that can be developed in Bandung district are rice, corn, potatoes, cucumbers, cassava, peanuts, and upland rice. In addition to food crops and vegetables, plantation crops such as cocoa, coffee, and tea, cloves have the potential to be developed especially in the southern part of Kabupaten Bandung.

Kabupaten Bandung is one of the contributing districts of food in West Java province. Based on data from Central Bureau of Statistics 2016, paddy production in Bandung district is 446.478 ton/year with the productivity of 5,99 ton/ha, corn production 53,413 ton/year with productivity level of 5,34 ton/ha, soybean production of 202 tons/ year with productivity level of 0.73 tons/ ha, sweet potato production of 33.568 tons/ year with productivity level of 18.19 tons/ ha. The location of food crop production did not spread evenly in Kabupaten Bandung, due to the land and climate physiography condition.

Central and Northern part of Kabupaten Bandung are the only regions that produces food crops. Land productivity is average in all production area. The productivity of land in Kabupaten Bandung for rice plant is 64,45 quintal/hectare, corn is 70,35 quintal/ hectare, soybean is 14,01 quintal/hectare and sweet potato is 211,37 quintal/hectare. Land productivity for crops on average increased from 2014-2016. The fulfillment of food and nutrition needs of the population is achieved through the production increase and food availability, pricing policies and food reserves, food industry, food industry supervision, and community participation (Karsin, 2004).

Based on the results of Alos Citra analysis shown in Figure 2, actual land availability for food crops is currently 52.790 hectares with the current type of land use in the form of rice fields and cultivation. While the availability of potential land for food crops amounted to 64,970 hectares with the current type of land use in the form of bushes and plantations. The proportion of area and location of potential land spreading did not considered as legal aspect as well as local regulation about the spatial plan as stated in RTRW / RDTR Kabupaten Bandung. To obtain the potential area of food crops development, it is necessary to conduct more detailed research related to the aspect of government policy.

4. CONCLUSION

There are 4 types of soil in Kabupaten Bandung, the dominant soil types are Andosol Eutrik (54.249 Ha), Gleisol Eutrik (47.224 Ha) and Cambisol Eutrik (46,659 Ha). The soil fertility status in KabupatenBandung varies from very low to high. Soil pH conditions ranged from acid to neutral.

The actual availability of land for food crops is currently 52.790 hectares with the current type of land use in the form of rice fields and cultivation. While the availability of potential land for food crops are amounted to 64,970 hectares with the current type of land use in the form of bushes and plantations.

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