

REVEGETATION EFFORTS AT FORMER MINING LAND IN CITATAH KARS AREA WEST BANDUNG REGENCY

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Abstract

Citatah karst area is the oldest kars in West Java that located in District Cipatat West Bandung Regency. Karst area in Cipatat District Gunung Masigit Village has 1,053 Ha area, one of the areas that have a potential of cultural heritage and geological reserves. Mining activities conducted in the kars area Citatah Gunung Masigit Village, in the form of active mining and post mining, resulting in decreased quality of physical, chemical, and biological soil fertility. To solve problems in post-mining areas, governments should be able to replace community livelihoods (such as limestone mining) to agriculture, farming, tourism and the creative economy. Through the efforts of plant revegetation. Several options plan that will be developed based on environmental, social, and economic conditions. Selection of plants for revegetation purposes, will be analyzed using Analytical Hierarchy Process (AHP), while to know the public response to revegetation and soil fertility assessment, will be analyzed descriptively. Based on the results obtained from the community response level, a positive response from the AHP analysis of the agrotourism revegetation program has a relative value of 0.834 states agreement for revegetation program with each positive response given that the most positive response is a conative response of 0.395, continued by cognitive response 0.277, affective response 0.199, while the relative value of the lowest response were shown in the negative response of 0.13. On the type of election plant revegetation, has acquired the plant revegetation well developed based on the relative value of the highest to the lowest of which is; 1). Corn (0.338 the highest crop species to be a revegetation commodity in both of social, economic and environmental conditions, 2). Guava (0,216), 3). Albasiah (0.109), 4). Cassava (0.084), 5). Soybean (0,043), 6) Cucumbers, Bananas, yam each have a relative value (0.042). Albasiah and nuts, can be used as pioneer plants to improve the fertility of the land before being developed in fruit and vegetable crops.

Keywords: Revegetation, Karst, AHP, Citatah

BACKGROUND

Karst topography is a unique topographical formation with the appearance or distinctive phenomenon resulting from the process of dissolving and precipitation of CaCO₃ back above and below the surface of the Earth, besides, karst landforms such as karst can also occur from weathering processes, hydraulic work such as tectonic movements, annihilation, the melting ice, and evacuation of igneous rocks (lava) because the main processes of the formation is not dissolving, then a landscape so called pseudokarst (Milanovic , 1996). Karst ecosystems were one of first human habitats where the caves provided steady dwellings near water and forest resources for their daily basic needs. Karst landscapes form in areas with

carbonate bedrock which is subjected to slow dissolution processes as result of a combination of temperature, chemistry and soil acidity. Water is the main agent of landscape change in Karst terrains (Fleury,2009).

The region of kars Food located in Cipatat subdistrict of West Bandung Regency is one of the oldest areas of kars in West Java. The region of kars in the Mountain Village of Masigit Food has an area of 1,053 Ha, one of the areas that have the potential of cultural heritage and geological nature reserve (Mountain Village Masigit Profile, 2015). West Java province Perda No. 2/2002 article 14, each planning region development in the area that has been set to be the area of the nature reserve of the geology, water and resapan areas of the region of kars, is obligated to get consideration from the Office of geology related.

Land development post mining through the orchard, is an attempt at revegetasi area of post mining to increase the economic value of society and improve the aesthetics of the land (Tjahyana, 2011). According to Rahmawaty (2002), the main purpose of the rehabilitation of the region of kars through revegetasi is creating an acceleration of land by the closure of the vegetation succession established according to Kurniawan (2001), revegetasi can be done by replanting trees that once existed, prior to logging the result of human activities. So get the revegetasi good, the need for caution in the reorganized towards the ground and shoots to maintain the fertility of the soil planting media. According to Iskandar (2008), the parameters concerning the revegetasi in plant needs to grow with good to note, such as limiting plant growth pertaining to land, either physical or chemical delimiters need to be addressed with the proper way.

Karst processes have potential hazards. Human activities throughout the world, connect and interact with the natural environment, explore the resources, create the hazardous processes. Escalating human occupation upon Karst terrain and hazard exposure will result in ceaseless impacts and risk. Geomorphic features and processes were an essential part of social survival when humans first begin adapting, learning and communicating finding about the environment. Human impact on Karst environment in the prehistoric time was very limited with a low probability of damage to properties and people. (De Waele, Gutierrez, Parise, and Plan 2011).

Before the West Bandung Regency publishes perda himself, all the Affairs of Government still refer to perda generated Bandung Regency. Based on Perda No. Bandung Regency 12/2001 about Spatial, note that the use of space for mining and industry (including processing industry lime) have exceeded the allocated space. Whereas in consequence of the publication of the Bandung Regent Regulation No. 8 of 2004 concerning overflow Most Bupati to Head Government Environment in Bandung Regency, covering 25 fields, including mining and energy, has caused a lot of problems because the authority overflow exceed the capacity of a town. In addition to the mining management did not go well, the licensing authority of a given sub has been accelerating damage to the karst Citatah – Rajamandala, due to lack of regard for the principle of conservation and environmental sustainability.

METHODS

The research was conducted in two places in October 2015-August 2016. First place in the acreage of land Mountain Village area Food kars Masigit post mining acres located in four Hamlets shown on Image Map with a scale of 1:25000 including 3.1, namely: 1) hamlet of Cibukur, a mountain Hamlet 2). Masigit, 3). Hamlet Girimulya and 4). The Hamlet Of Mekarmulya. Second place, research done in the laboratory of the Department of soil science faculty of Agriculture University of Padjadjaran Bandung, to test the physical and chemical properties of the soil.

A. Qualitative

Qualitative methods are generally used to describe a place of research, description of activities in the process of determining the type of plant revegetasi in the village of Mount Masigit and analysis of factors that affect response. The data obtained from the qualitative method, sourced from the primary and secondary data.

B. Quantitative

Quantitative methods are collected to test the theory in the determination of the best crop of revegetasi in the village Masigit Mountains through interviews 21 structured. Quantitative methods serve to know the response community in the program revegetasi revegetasi plant type of election results in the area of research, to development of revegetasi influenced by economic factors, social and ecology.

C. Tools and Materials

The tools and materials used to test soil fertility, use field equipment shown in Table 3.1. The materials used in this research are: soil samples as objects and supporting materials of soil chemical analysis (C, N, P, K, pH) as well as the physic of soils (texture and porosity).

Table 3.1 Fieldworks Equipment

No	Tools Name	Function
1	Stationery and labels	Registration and grant of a code on the soil sample
2	Bor tanah	Create a unit cross-sectional observation of soil vertically
3	Hoes and Knife	Land units and for observations of menipit
4	GPS	Poitm Cordinates
5	Plastic	Place of sampling
6	Ring samples	Soil sampling instrument for porosity

Source: Secondary Data, 2016

C. Soil Samples

Soil samples were taken randomly with a total area of 15 Ha, from a sample representing the SPL (a unit of land use map) obtained as 6 soil samples taken at the site of the research. SPL which represents, taken with a slope vulnerable slopes ranged from 0-25%, the condition is a condition that is suitable for farming. Soil sampling was done randomly by the distance between the soil samples 100 m, then dikompositkan as much as 1 kg. Composite soil samples were then analyzed in the laboratory of chemistry. Methods of analysis of the physical properties or chemical properties of the soil, shown in Table 1.1.

Tabel 1.1 Physical and chemical properties of the method of soil were observed_____

No	Chemical Properties of Soil	Metode
1	pH H ₂ O	Elektrometri
2	C organik (%)	Walkley & Black
3	N total (%)	Kjeldahl
4	P available (mg/kg)	Bray I
5	K (cmol/kg)	Asam Klorida
6	C/N rasio	

No	Physical Properties of Soil	Metode
1	Tekstur	Pipet
2	Porositas	Granulometri

Source: 2016, Secondary Data

RESULTS AND DISCUSSION

Geological Conditions

Geological structure of Gunung Masigit Village belongs to karst Citatah- Rajamandala area. Kars Citatah- Rajamandala area is hills which formed of claystone. Prominent morphology is 42 hills of karst which occurred on limestones, Formasi Rajamandala formation consists of carbonate rocks (Program Penyuluhan Pertanian, 2016). Based on the order of geological structures, Desa Gunung Masigit Village consists of:

a. Limestone of Rajamandala Formation (Oml)

Structure of Tertiary Oligocene rocks is solid limestone thus layered limestone, which generally light colored with big abundant foraminifera.

b. Clay, Napal, Lempung, Napal, Quartz Sandstone of Rajamandala formation (Omc)

Structure of Tertiary Oligocene rocks which is dark grey to black clay, napal clay, napal globigerina, quartz sandstone, and quartz crust contains mica sheets, coal strips.

c. Sandstone and Siltstone of Citarum Formation (Mts)

Structure of Tertiary Miocene rocks is sandstone perfect layered, alternated with siltstone, claystone, grauwacke, and breccia which show characteristic of turbidite. Sediment structure like coated layers convolute lamination, current ripple lamination, worm sites and others look abundant.

d. Kind of Breccias and Sandstone of Citarum Formation (Mtb)

Structure of Tertiary Miocene rocks is polymic breccia with basal, andesite, and limestone, sandstone and siltstone components, as well as horenblen crystals.

e. From the old volcano (Qob)

Structure of Quarternary rocks is breccia, lava, volcanic breccia lava, flow breccia, lava sediment and lava that shows out the plates and many arrangements between andesite and basalt.



Fig. 1.1. Condition of Landscape in Research Location (Source: Koesoemadinata, 2004).

Society response to the revegetation plan

Respondents interview result about positif response was acceptance or refusing to the revegetation program are showed on Figure 4. 6. Former components of society response to participate in the program are determined, they are:

1. Cognitif response which determine knowledge or reliance of society to the environment, economic and social condition.
2. Affective response which determine acceptance or refusing of society to revegetation program.

3. Conative response which determine the action of society to participate by giving idea/ thought, action, providing media and infrastructure, and controlling revegetation.

Rosenberg and Ovland (1960) in Ajzen (1988) stated that there are three main components to form human response, they are 1). Cognitive Kognitif (reponses of perception and statemet about what they believe/know), 2). Affective (response of symphaty nerve and emotional reaction), 3). Conative (response of action and statement about behavior).

Percentage rate of response from responses toward revegetation program plan generally is showed in Figure 1.2. There are positive and negative responses that given by the society regarding to revegetation program plan. Figure 1.2 showed AHP analyzes result is mostly showed positive response about agrotourism revegetation, with value 0.834, agree to revegetation program, the greater positive response value is conative response about 0.395, continued by cognitive response about 0.277 then affective response about 0.199, otherwise the lowest value is showed in negative response about 0.13.

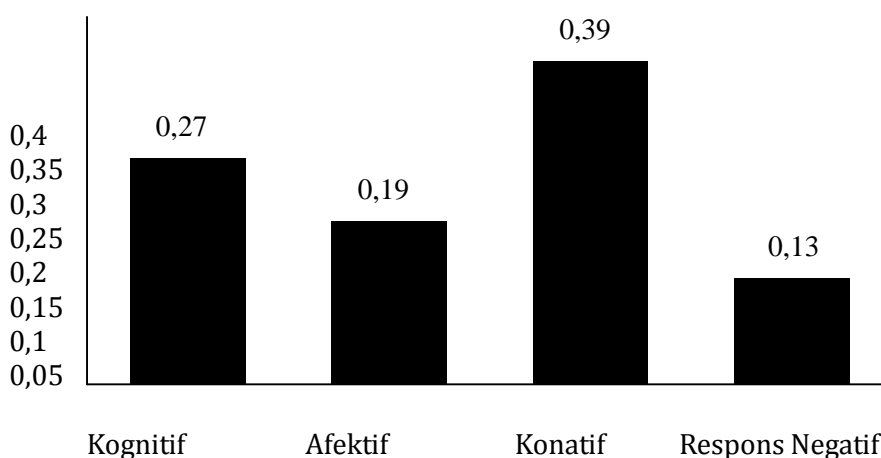


Fig. 1.2 Rate of Society Response in Determining Revegetation of Kars in Gunung Masigit Village

(Source: Analysis Expert Choice, 2016)

Types of negative response that obtained from interview results, generally are:

1. Response that showed ignorance about the diversity of local plants species in research location.
2. Responses do not know the information about agriculture, about environment, social, and economic condition because of less information about agriculture in kars area from government.
3. Responses do not want to change their livelihood to agriculture. They assume income in agriculture is lower than manufacturer labor or merchant.
4. Response of support the revegetation program, but do not want to involve in organizing the revegetation program. Responses were thinking that revegetation is local people and government responsibility.



Fig. 1.3 Limestone Manufacture Industry Arround Research Location.



Fig.1.4 Area in Stone Garden Toursim which Threatned by Mining Activity

Analysis of Soil Fertility

Porosity

Table 1.2 is showed the porosities of soil in each samples taken from research location. Posorities value in table 1.2 are about 49,06% -58,87%, porosity is counted good. Capability of soil to absorb nutrient and water is good.

Table 1.2 Results of Soil Porosity Analysis

Parameter Code	Porosity (%)	Result
GM 001	49,06	Less Good
GM 002	58,87	Good
GM 003	55,47	Good
GM 004	55,47	Good
GM 005	52,83	Good
GM 006	55,47	Good

Source: Analysis of Soil Physic Laboratory, UNPAD, 2016

Soil pH

Table 1.3 is showed soil pH of each samples taken from research location.

Parameter Code	H ₂ O pH	Result
GM 001	7,8	Sour
GM 002	6,8	Neutral
GM 003	6,5	Sour
GM 004	8,3	Sour
GM 005	7,3	Neutral
GM 006	7,6	Neutral

Source: Aanalysis of Soil Chemical ,UNPAD, 2016

Table 1.3 is showed soil pH in research location are alkalis and neutral. According to Novriani (2010), acid to alkaline pH is suitable to maize agriculture.

Texture

Table 1.4 is showed result of soil texture of each sample taken in location.

Table 1.4 Result of Soil Texture Analysis

Parameter Code	Texture			Result
	Sand	Silt	Clay	
GM 001	7	34	59	Clay
GM 002	10	30	60	Clay
GM 003	3	17	80	Clay
GM 004	9	29	63	Clay
GM 005	9	29	62	Clay
GM 006	8	33	59	Clay

Source: Analysis of Soil Physic Laboratory, UNPAD, 2016

Table 1.4 is showed soil texture in the location is clay, which means soil texture in the research location is good to develop crops. Agriculture Land that suitable for crops is soil textured clay to sandy clay

Chemical Characteristi

Potassium

Result of soil determination about potassium content is showed in Table 1.

Table 1.5 Value of Potassium Analysis

Parameter Code	Potassium (mg/100g)	Result
GM 001	34,21	Middle
GM 002	28,66	Middle
GM 003	62,53	Very High
GM 004	51,59	Very High
GM 005	8,34	Very low
GM 006	31,03	Middle

Source: Analysis of Soil Chemical Laboratory, UNPAD, 2016

Result of soil potassium analysis is showed in Table 1.5, potassium content in research location is very low to very high. According to Herweg (2002) plant needs potassium about 1% (10.000 ppm). Maize can survive in dry land with very high to very low potassium content (Yuanianto, 2009).

Phosphor

Result of phosphor content determination is showed in Table 4.1.

Table 1.6 Result of Soil Phosphor Analysis

Parameter Code	Phosphor (ppm P)	Result
GM 001	20,61	Very high
GM 002	8,61	Middle
GM 003	18,31	High
GM 004	20,61	Very high
GM 005	0,47	Very low
GM 006	3,4	Very Low

Source: Analysis of Soil Chemical Laboratory, UNPAD, 2016

Table 1.6 is Sourceowed value of phosphor in research location has variation from very low to very high.

Nitrogen

Result of total nitrogen determination in soil is showed in Table 1.7.

Tabel 1.7 Result of Nitrogen Analysis

Parameter Code	Nitrogen (%)	Result
GM 001	0,16	Low
GM 002	0,19	Low
GM 003	0,12	Low
GM 004	0,17	Low
GM 005	0,19	Low
GM 006	0,19	Low

Source: Analysis of Soil Chemical Laboratory, UNPAD, 2016

Analysis result of soil nitrogen is showed in Table 1.7 soil nitrogen content in research location is low.

Soil C Organic

Result of soil C organic content determination in showed in Table 1.8.

Tabel 1.8 Result of Soil C Organic Analysis

Source: Analysis of Soil Chemical Laboratory, UNPAD, 2016

Parameter Code	C Organic (%)	Result
GM 001	2,69	Middle
GM 002	2,47	Middle
GM 003	1,69	Low
GM 004	1,48	Low
GM 005	1,98	Low
GM 006	1,90	Low

table 1.8 is showed low to middle C organic content in research location. Utilization of maize commodity can be developed in low C organic and dry land by addition fertilizer to reach maximum growth (Kariada et al, 2006).

Consideration in Choosing Revegetation Plant Based on Suitability of Local Commodity which Developed the Most

Consideration of choosing plant to be revegetation plant are economic, social and environment aspects, based on diversity of local species that suitable and developed more in research location because of society, government and agriculture department, and previous research are showed in Table 1.9.

Table 1.9 Dominant Plant Commodities Developed in Research Location

Commodity Species	Number of Responce Choice (people)
Soybean	7
Maize	19
Banana	8
Cassava	11
Sweet Potato	9
Cucumber	8
Guava	16
Albasiah	14

Source: Result of Primer Data, 2016

Table 1.9 is showed that plant which dominant developed in the location can be reference of local species for revegetation program, they are guava 16, maize 19, albasiah 14. Diversity of species commodity which developed by the local people in Gunung Masigit Village in research location is showed in attachment. Planting of agriculture commodity in post mining area is needed many information to choose plant species which suitable to be developed by local ability.

Based on consideration of revegetation plant suitability which dominant to be developed in research location and has the biggest portion in social, economic and environment aspects. Consideration result of revegetation plant is analyzed by AHP (Anayisis Expert Choice) to obtain the best revegetation plant for program research location.

Result of Consideration in Choosing Species for Revegetation of Kars Citatah Area in Gunung Masigit Village

Result of consideration plant species for revegetation is based on the technic of choosing plant commodity from the highest to the lowest portion which can support the revegetation program like in Figure 1.5, they are: 1. Maize (0.338), 2. Guava (0,216), 3. Albasiah (0.109), 4. Each of Rice dan Cassava (0,084), 5. Soybean (0,043) 6. Each of Cucumber, Sweet Potato, Banana (0,042). Others commodity from AHP analysis result, can be recommendation to local people, government, related department, about plant species for revegetation to support agrotourism.

Choosing Albasiah plant and legumes, according to informan can be recommendation to be pioneer plant to enhance soil quality of post mining area. After the post mining area is considered ready to develop to br agriculture land, can be started planting horticulture crops.

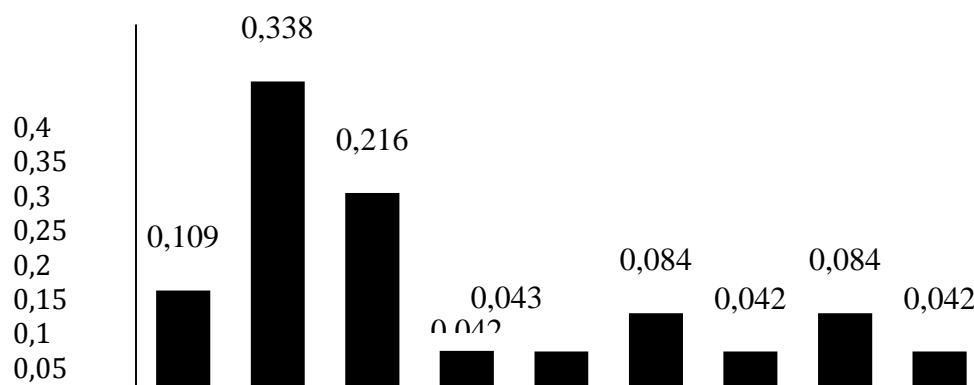


Fig. 1.5 Revegetation Plant of Kars Area in Gunung Masigit Village
(Source: Analysis Result of Expert Choice, 2016)

Based on result of consideration choosing revegetation species plant from economic, social and environment aspects is obtained commodity that can be recommendation for revegetation program, they are: 1. Maize (0.338), 2. Guava (0,216), 3. Albasiah (0.109), 4. Each of rice and cassava (0,084), 5. Soybean (0,043), and 6. Each of cucumber, sweet potato, and banana (0,042).

Consideration of recommendation revegetation plant species is needed to be noticed for land conservation in marginal area. Lime or sand post mining condition in Gunung Masigit Village area generally has marginal structure land condition. The condition of the marginal land is needed conservation step before develop the revegetation commodity or choosing species that can survive in marginal condition. Land characteristic that found in research area can be considered to the suitability of revegetation plant in each location. Table 1.10 shows research area condition in each location reviewed by map overlay.

Land Characteristic	Village Name			
	Cibukur	Gunung Mas	Mekarmulya	Girimulya
Lansekap	Karst	Karst	Karst	Karst
Slope	0-25%	8-4%	0-40%	0-25%
Landuse	Rice Fields	Fields	Settlement, Fields	Settlement, Fields
Stone	Limestone	Limestone	Limestone	Limestone
Type of Soil	Sandy	Sandy	Sandy	Sandy

Source: SPL overlay 2016

Land mapping unit showed that post mining land condition in research location has land shape characteristic tectonic karst hills, slope among 0 - >40%, rocks of calcareous rocks and sandstone, land use form are rice field, field, moor and shrubs. The characteristics of each plant commodity to survive in the environment, indicating the special features in order to survive, it is shown in Table 4.21.

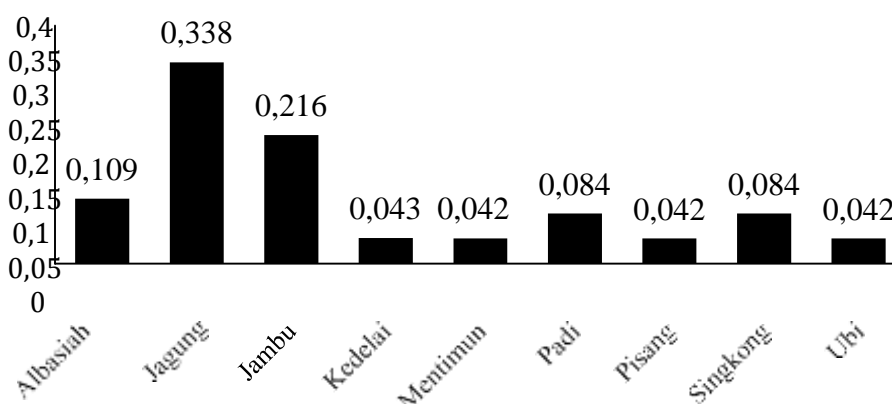
Tabel 1.11 Characteristic of Revegetation Plant Commodity That Can Be Developed in Research Location

Plant Type	Karakteristik Lahan		
	Slope	Land use	Altitude (mdpl)
Seasonal Plants			
Cassava	<8% - <30%	Shrubs	0-2000
Sweet Potatoes	<8% - <30%	Shrubs	500-1000
Cord	<8% - <30%	Shrubs	100-1800
Rice	<3% - <8%	Rice fields	0-1500
Cucumber	<3% - <8%	Shrubs	100-1200
Soybean	<3% - <8%	Shrubs	0-700
Annual Plants			
Banana	0% - <35%	Plantation, Fields	1000-2000
Albasiah	<3% - <35%	Plantation, Fields	0-800
Guava	0% - <30%	Plantation, Fields	5-1200

Source: Secondary data, 2016

Determination of commodities that can be developed in research location is showed in Table 1.11. Some literature describe that revegetation plant that have been examined to be developed in post mining area as revegetation plants, they were coarse grain, pulses, root, and tuber crops, fruit, and pioneer plants. Type of land utilization in post mining area is showed in land mapping unit (attachment 5), they are shrubs, farm and field, because of that rice is not suitable to be revegetation plant before the land condition really has good performance as a paddy field requirements. The potential of rice development in Cibukur Village can be recommended in paddy field not the post mining area.

Consideration of revegetation plant species based on commodity plant technique can support the revegetation program based on the highest relative value to the lowest relative value as shown in Figure 4.30 they are: 1. Maize (0,338), 2. Guava (0,216), 3. Albasiah (0,109), 4. Each of rice and cassava (0,084). 5. Soybean (0,043) 6. Each of cucumber, sweet potato, and banana (0,042). Commodities of AHP analysis result can be recommendation for local people, government or related instance about revegetation plant species to support Creative Economic in Agrotourism.



Gambar 1.6 Revegetation Plant in Kars Area Gunung Masigit Village (Source: Expert Choice Analysis, 2016)

CONCLUSION

1. Selection of revegetation plant is based on three approaches, they are:
 - a. Environment, the highest to the lowest relative values are maize 0,221, albasiah 0,163 and guava 0,149, respectively.
 - b. Social, the highest to the lowest relative values are maize 0,09, cassava 0,084, and guava 0,077, respectively.
 - c. Economic, the highest to the lowest relative values are maize 0,246, rice 0,208, and guava 0,146, respectively.
2. Based on approaching result of plant selection obtained some commodities of revegetation plant that suitable to be developed according to relative value, they are: 1). Maize (0.338) the highest relative value, which is a good revegetation plant in social, economic and environment condition, 2). Guava (0,216), 3). Albasiah (0.109), 4). Each of Rice and Cassava (0,084). 5). Soybean (0,043) 6) Each of Cucumber, Sweet potato, and banana (0,042).

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