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Vegetation Management of the Welia System Based on Local Wisdom in Wakatobi Island Communities

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***Abstract**: - Welia is a rocky land management system in red bean (Phaseolus vulgaris L.) cultivation. It is implemented based on local community wisdom. This system is thought to minimize impact of land burning in the form of vegetation loss. This happened at the slash and burn system in conventional farming activities. This study aimed to study vegetation management based on local wisdom in the welia system which affects soil and plant systems. The research was conducted in the Wakatobi archipelago, Southeast Sulawesi Province, Indonesia. Primary data were obtained through observation, interviews, microclimate measurements, and analysis of soil samples. Secondary data were obtained from literature studies. The data were analyzed qualitatively using the triangulation method. The results of this study indicated that vegetation management in the welia system by slashing or trimming the selected pole vegetation. This was done to design climbing poles or modifying the pile canopy architecture. The modification could maintain diversity of tree populations, limit plant growing space, and optimize red bean crop production due to the creation of a microclimate and localization of the nutrient cycle. Based on the results of this study, welia could maintain the diversity of land vegetation so that it was profitable ecologically, economically and socio-culture.*

***Key-Words:** local wisdom, vegetation, wakatobi, welia*

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I. Introduction

Indonesia is an archipelago country. One of them is the Tukang Besi archipelago in Wakatobi regency, Southeast Sulawesi, Indonesia. The small islands have different and distinctive ecological, economic and socio-cultural characteristics. These characteristics have led to the designation of the Tukang Besi Islands as a National Marine Park, a biosphere reserve, the center of the world's coral triangle, and a National Tourism Strategy Area. A series of studies have been conducted to explore the potential natural resources of the Tukang Besi Islands, but there has been no research on vegetation management in relation to cultivation. Archipelago communities are believed a number of indigenous plant cultivation systems, but studies are still very limited.

The Tukang Besi Islands are consists of several small islands. One of them is Wangi-Wangi Island which has an area of 156.5 km2 (Haryono et al., 2014) and a population density of 213 km2 (BPS, 2018). Cultivation in Wangi-Wangi Island is done on rocky soil. The land in the form of a terrace is composed of coral limestone and klastika limestone (Satyana and Purwaningsih, 2012) with little soil. Based on the classification of Schmidt and Ferguson, the island has a type E climate (relatively dry area) with savannah vegetation. The water source for the cultivation system comes only from rainwater catchments. This means that the management of vegetation on the land is relatively dry throughout the year.

The Wangi-Wangi Island community has local wisdom in managing of natural resources and the environment (Mananand Arafah, 2000), forest-farmmanagement (Arafah, 2011), agricultural systems (Harviyaddin, 2005), agricultural land conservation (Hidrawati, 2019) so that can support sustainable food security (Hidrawati et al., 2016; Kandari et al., 2017). Local knowledge-based land management can be found farmers in Sumam, Ghana (Ehiakpor et al., 2016), farmers in Ondo State, Nigeria (Oluwatusin, 2014), India

(Kumar, 2014) or farmers on Maltase Island (Charles and Johann, 2016). Agriculture (farming) for the Wangi-Wangi Island community is the core of culture (Arafah, 2010) the way of life (Harviyaddin, 2005) and the backbone of the farmer household economy (BPS, 2018)

Weliasystem is a management of savanna vegetation for cultivation activities on Wangi-Wangi. According to oral tradition, the word welia is a transformation of the word Wolio which means slashing (Rosdin, 2014; Rosdin, 2015; Mujabuddawat, 2015). Wolio is known as the center of the Buton Kingdom on Buton Island. Welia's supporters are still found in several groups of the Buton royal alliance around the Buton Islands and TukangBesi Islands. Currently, welia is still the choice for red bean cultivation. Besides that, corn, tubers, pumpkin and cassava are also cultivated. Welia has become a symbol of Butonese identity, a symbol of land ownership and social status and has undergone a transformation in the culture of the Mandati community on Wangi-Wangi Island. The management of the welia system is similar to traditional agroforestry systems such as the Dusun system (Kaya et al., 2002), Lawa and Lela (Sasaoka et al., 2014) on small islands and Talun farms (Parikesit et al., 2018), Daleh (Imang et al., 2018) on large islands based on local wisdom.

II. Materials and Methods

The research was conducted from April 2018 to August 2019 in the Wangi-Wangi Island, Wakatobi archipelago, Southeast Sulawesi Province, Indonesia. The research started with a vegetation analysis and a survey to determine the location and plants. The location research was determined by purposive sampling based on research objectives. Based on the results of observations and interviews, the selected farming locations were in Matahora Village, Wangi-Wangi Island. Matahora Village is considered representative the similarity of the welia system by farmers, the geographical, economic and social conditions of all village areas in the Wakatobi Islands.

Information collected by snowball techniques, start with determining the base informants and then leading to the selection of several key informants. This study involved 2 base informant and 63 key informants. The key informants consisted of 38 men and 25 women with ages ranging from 48 to 75 years. The base informants were determined purposively and were the people to know most about the conditions of the research area. He had also able to direct researchers to obtain data and information according to research objectives. The key informant had the criteria, namely head of the family, at least 45 years old, farming in welia land and knowing about the welia system. The subjects who were the main informants in this study were farmers who implement the Welia system, community leaders, and agriculture government officials.

Primary data obtained through observation, interviews and measurement results of rainfall, microclimate, temperature, and solar radiation. The physical and chemical of soil analysis in the Soil Research Institute, Balitbang, Ministry of Agriculture, Republic of Indonesia. The components of soil fertility analyzed consisted of texture, pH, C-organic (%), N-total (%), C / N ratio, P (ppm), K (me 100 g-1), Mg (me 100 g- 1), CEC (me 100 g-1), base saturation (%) and very thin soil depth (<20 cm). Furthermore, data triangulation was carried out to assess the validity of the data through observation, interviews, laboratories analysis and literature search results related to the object of research.

III. Results and Discussion

The welia system based on local wisdom is a system of cultivation rocky land management. It is presumed have been practiced by the Wangi-Wangi Island communities for a long time. This was done to minimize the impact of land burning in the form of the loss of all vegetation, in the slash and burn system in conventional farming activities. Welia's land under controlled burning still leaves behind the pole vegetation for climbing red beans (Phaseolus vulgaris L.). This knowledge of traditional agricultural techniques designs climbing poles or modifies the canopy architecture for trending crop climbing. Red bean growth is limited, the pattern and distribution of canopy propagation and optimizes the use of limited nutrients in order to form optimal seeds. In addition, welia's management practices provide justification for the full commitment and responsibility of the community in relation to maintaining land cover and vegetation, land fertility, and creating a microclimate and community food security.

Welia land was selected based on fertility with indicators namely vegetation diversity, soil depth, and the amount of soil attached to the rock. The fertile land is characterized by coastal Pandanus vegetation, Banyan trees (Ficus benyamina L.), Balande and other shrubs. The less fertile soils are characterized by Alang-alang (Imperata cilindrica L.), Komba-komba (Eupatorium odoratum L.) and pasture. Welia's land selection took into account the distribution of beach Pandanus and Banyan trees. The distribution of coastal Pandanus and Banyan trees in one landscape inspires the proportion of welia farm. This means that in one landscape, welia's not all land can be developed technically. Therefore, welia's land selection must consider the existence of coastal Pandanus. In addition, the community believes that welia will be better developed around the coastal Pandanus clump. Land suitable for welia, apart from considering coastal Pandanus vegetation, also pays attention to the presence of Banyan trees. These two plants are the main indicators in welia's land selection. Coastal Pandanus vegetation has ecological, economic, and socio-cultural values for the community,especially tothe Matahora Village society on Wangi-Wangi Island. The coastal vegetation of Pandanus and welia is a dialetic relationship of vegetation management.

The geology of Matahora Village as the locus of this research consists of coral limestone and clastic limestone with little soil. Geological history is closely related to the level of soil fertility, including the dominance of calcium nutrients in the soil content. The results of soil analysis on welia land have a low fertility level, as shown in Table 1.

Table 1 Fertility Dynamics of Welia with Prepared by Burning (WB) and Without Burning (WTB)

Parameter	WB	WTB
Ph (H_2O)	8,1	8,10
pH (KCl)	7,4	7,37
Nitrogen (%)	1,71	1,93
C-Organic (%)	17,16	17,21
Phosphorus (ppm)	18	23,33
Calcium (me/100 grams)	64,18	64,66
Magnesium (me/100 grams)	3,18	3,21
Potassium (me/100 grams)	0,04	0,08
Sodium (me/100 grams)	0,29	0,34
KTK (me/100 gram)	66,52	66,06

Source: Results of analysis in the Soil Research Center, Bogor, 2018

Table 1 showed that soil fertility was very low on the welia land prepared by burning (WB) and without burning (WTB). Welia land prepared by burning, Phosphorus has decreased, followed by Nitrogen, Calcium, Magnesium, Potassium, and Sodium. Welia land prepared without burning,cation exchange capacity (CEC) has decrease, whereas on the land burned CEC increasing tends. This is closely related to the ground reaction. CEC in general can provide an overview of the number cations soil (Ca^{2+}, Mg^{2+}, K^+, Na^+, NH^{4+}, H^+, and Al^{3+}) in available forms that can be utilized by plants and microorganisms. The cations nutrients needed by plants. In general, the soil reaction neutral level and shifts to slightly acidic. This is due to the geological history of Wangi-Wangi Island.

Burning in welia land was controlled manner to accelerating rock mineralization breaking seed dormancy, producing smoke and ash. Combustion increases CO_2 turbidity in the plants canopy and plants around them. The community believes that smoke was good nutrition for plants. According to the farmers, burning benefits to reduce costs and use labor, plants avoid disease, soil becomes fertile and dormancy breaks vegetation seeds. Uncontrolled burning would rocks scorch, seeds burn and vegetation roots so that the form of padhangkuku[1] land. Welia land burning must be quickly as possible with temperatures formed only to heat land, but not to burn the stone into charred, burn vegetation seeds in the rock gaps and not kill vegetation root system runs under the rock surface and soil. Farming activity is related fire use to clear land (Jacobson, 2014; Wallenfang et al., 2015; Rösch et al., 2017) and subsistence. Burning rocky spot done with controlled use of fire. Burn (sula) begins with making a flame at the edge of needed land. It was meant to be estimate would long fire spread in the other parts. Burn started from the opposite wind direction so that the fire could be controlled and perfect burning. According to the farmers, the best burning characteristic showed that the first succession formed, i.e. seedlings vegetation from prospective welia, not grass likes ImperatacilindricaL. or Eupatorium odoratumL.

Welia implementation begins with land clearing. It was land clearing by uprooting done grass vegetation, modifying pole and burning. Literally, welia could be interpreted as "slash". Slash mean isopening land activity on rest pole vegetation. It was cutting pole as high 150-160 cm as a place for climbing red beans. Pole height was adjusted to the farmerphysical condition. Farmers who have a high height would have implications for welia height. Separating land poles main feature of welia system. It means that the land vegetation maintained. Welia distinguishes from conventional farming systems which all totally cleared of land vegetation.

Vegetation Management of Welia System

Welia's farming as a traditional crop cultivation system of the Wangi-Wangi Island community that has been practiced for a long time based on local wisdom. The native crop cultivation system was based on local wisdom such as shifting cultivation on Palawan Island, Philippines (Dressler and Pulhin, 2010). Local wisdom involves calculating moon movements such as the "Ua‘ afa le Aso "calendar on the Samoa Island (Lefale, 2010), the Wariga calendar in Bali (Narottama et al., 2017). Local knowledge or local wisdom has become an

[1]The name of the forest area with grass and shrub vegetation

important part in the conservation of agro-biodiversity in Nepal (Upadhya et al., 2016), agroecosystem conservation in Tamil Nadu (Immanuel et al., 2010), assessment of land degradation in Africa (Stringer and Reed, 2006), indicators of soil fertility in Latin America (Barrios et al., 2006), agro-morphological evaluation in West Africa (Assogbadjo et al., 2012), agroforestry (Kabir et al., 2016), agroforestry tree selection (Salampessy et al., 2007) and agronomic practices (Sumberg et al., 2003). Behavior that produces pleasant outcomes tends to be repeated (Thorndike's law of effect) by farmers. Farmers developed simple experiments (Hawkin and Van De Ban, 1999) and observations over a long time period (Speranza et al., 2010) to developweliafarming based on local wisdom in Wangi-Wangi Island. The agricultural systems developed based on community knowledge or local wisdom can be socially, economically and ecologically sustainable (Reijntjes, et.al., 1999; Bachev et.al., 2017; 2019).

Welia's ecology as a shifting cultivation activity shows sustainability to date with controlled land pressurerelatively. Arafah et al., (2011) states that the performance of Mandati customary forest emic is still the best. The 2017 Participatory Mapping result of Mandaticulture institutions indicate that the Mandati's culture forest (kaindea[2]andmotika[3]) has not decreased. Talaohu (2013) states that shifting cultivation relies on the period of maintain fertility and land productivity, throughout the period of coverage sufficient for the returning land productivitymechanism has no environmentnegative effect. Sasaoka et al., (2014) also stated that the relatively small scale of shifting fields (lawaand lela) creates a slight clearing pressure on SeramIslandforest. Communities develop adaptation strategies to control expansion into customary forests by only gathering forest and marine products and developing livelihoods (Arafah, 2011; Hidrawati et al, 2018). Customary institutions are revitalized to ensure access and use of sustainable custom management space.

The main problem in farming ecology was land fatigue which causes shifting cultivators. According to the community, welia land fatigue was overcome agronomically by using the right seeds. Land saturation had implications for the low soil and plantsproductivity, so farmers do rotate land (bhaliwuta) or rotate pith seeds from different land or other areas at different planting seasons. For example, seeds from the eastern planting season are cultivated in the western planting season or otherwise. In addition, rotating pithy seeds from welia of padhangkuku landscapeto ontoala[4] landscape, motokau[5] to padhangkuku or otherwise.

The ecological sustainability of cultivation was carried out agrocentrically[6]. Agro-centric views that humans, pests, and diseases inwelia system were part whole interconnected with one another. Pest and disease control was carried out by limiting the land with lines (bori) for four Fridays in four directions. First, it starts from the far right corner of the farm and then crosses the ground with the back of a small machete/crowbar eye while reciting mantras. The mantra contents basically invitations to pests and diseases, so that taking role and consumption of plants was not excessive, but still on the benefits principle that all life on earth can run in harmony and balance. It was like well as balancing the balance of carbohydrates and protein for the household.

Wangi-Wangi Island communitiesview agro-centric welia farms as the focus of all activities. Cultivation activities were the community as way of life. Dependence on farming was one of the community intrinsic motivations in maintaining farming activities, so that could be form community food security. Farmers take's from land and see, naturally. It showed that worked in the sea and took care of they farm was equally important for farmers in the small islands, so that the farming system was known as bivalent farming.It means the farmers cultivate land as same as the sea.

The development of welia's farm through a tree-pole pattern could increased the population density of trees outside the forest thereby increasing carbon stocks in the shifting cultivation system. Welia's farm was derived from a succession of tree poles that grow in one unit of land to form a distinctive architecture. The architecture of the canopy that was either shade or neighboring (relative neighbor effect). This forms a resource sharing system for temperature, wind speed, solar radiation and temperature. At present several important economic plants that were originally developed on open landbeing developed with resource sharing systems, for example in shaded environmental systems (Kwon and Woo, 2015) such as agroforestry systems (Shapiro and Frank, 2016) such as coffee (Boreux et al., 2016), brown rice (Muhidin et al., 2013), cocoa (Dawoe et al., 2016), and cotton (Norsworthy et al., 2016). The resource sharing system was well optimized by modifying the welia header in such a way as to be able to create nutrient cycle localization as the implication of the cropping system and microclimate dynamics expected to maintain soil fertility.

Good microclimate management in welia systems could reduce fungal attacks and increase vegetation diversity. Toropanga was a place where birds search for food, nest, and sleep, thereby increasing the diversity of plants in welia's farm where there was bird droppings and food scraps (seeds). Bird droppings and leftovers

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[2]The name of protected forest area with the constituent vegetationcharacteristics such as bamboo and palm;

[3]The name of production forest area with constituent vegetation such as sandalwood (*Santalum album*) and *biti* wood (*vitexcopacus*)

[4]The name of part land unit surrounded by *padhangkuku* which is dominated by form of polesor shrubsvegetation

[5]Plantation land under cultivation dominated by sap-sized vegetation

[6]the view that agriculture as center of human live (Reijntjes, et al., 1999; Valdez, 2014; Macassi, 2018)

could supply nutrients and seed sources. The toropanga around area was an open access that could be community used to gather grains such as cashew nuts (Anacardium occidentale L.) and walnuts (Canarium vulgare L). In addition, the toropangaa around area was often found grains that had a certain dormancy period such as papaya (Carica papaya L.) and melinjo (Gnetumgnemon Linn.) Where the dormant period disappears after the subject land fire controlled by farmers. The seeds grow a lot from the around area.

Some trees in welia's farm, some were left to grow until planting cycle ended, but some were cut down perpendicular to the logger eyes. The trees were used as a living pole (climbing pole). Life standard could protect the soil and plants from exposure to solar radiation, water blows and wind gusts, reduce the water's kenetic force to the soil surface, store carbon, and in the next planting season can be promoted as a protective tree (toropanga). Plants growth in welia's farm was a source of carbohydrates and vegetable protein in balance ensuring food of family level. Welia farmers in Wangi-Wangi Island develop and inherit this farming system, adapted to rocky, land subsystem conditions, without relying on mechanization, chemical fertilizers, pesticides or other technologies from modern agricultural science. This showed that welia was sophisticated and appropriated as a traditional agricultural practice on Wangi-Wangi Island.

Welia farm were basically anthropogenic. Its existence was due to the role of human activities in the farming system and the use of fire for burning land, maintaining plants, and post-harvest. The fire use on land only plays a role in the dynamics of Phosphorus nutrients (ppm) while other soil fertility parameters relatively stable (Table 1). Local communities had local accountability, so that they had full commitment and responsibility to manage resources (Korten, 1986). The managing responsibility in welia system built on for generations by adapting according to the ecological, economic and social cultural characteristics of Wangi-Wangi Island. The fact, various studies showed that local communities were a formidable fortress to stem the negative impacts of ecological, economic and social cultural land damage (Edmuns and Wollenberg 2003; Claridge and O'Callaghan 1995).

Welia was the Mandati indigenous communal identity. Welia farm had functions as a social and cultural media in reducing border conflicts (kaselapa) and restricting access to customary governance spaces. Kaselapa was a demarcation of agricultural systems in customary management areas that could be identified based on topography, vegetation, and farming systems. Welia land management system was developed based on the customary management area from land management, land selection, cultivars, and harvesting. Welia limited access to customary management spaces such as the motika and kaindea forests. Welia could be practiced only on padangkuku, ontoala, and motokau with stake vegetations size (trunk meter diameter>10 cm). If a land anysize vegetation of a pole (20 - 10 cm diameter trunk meter) and/or treesized vegetation (trunk meter diameter>20 cm), then the vegetation would only be used as firewood or allowed to grow into a toropangga. It indicated that the welia system only could be practiced outside the forest area, thereby maintaining the tree population diversity outside the forest so that it was not forest put pressure.

IV. Conclusion

Wangi-Wangi Island community develop and inherit the local wisdom based welia system in savannah vegetation managing by sophisticated and appropriated. Welia as a red bean climbing have limits plant growth space (vegetative phase) so as to optimize the red bean growth crop production (generative phase). The transformation of welia into toropangaa created a microclimate suitable for the red bean plants production, nutrient cycleslocalization in the soil-plant system and maintaining land vegetation diversity. Welia system could maintain tree population diversity outside the forest so that it was not forest put pressure. Welia still subsystem but was ecologically, economically and social culturally beneficial and ensures food security.

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