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STUDY OF LEVEL DRY LAND FERTILITY IN SUMBERKIMA VILLAGE, BULELENG REGENCY, BALI, INDONESIA

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Abstract

Reduced soil fertility can be a major factor affecting soil productivity, so the addition of nutrients in the soil is very important. The study was conducted in Sumberkima Village, Buleleng Regency, Bali Province because this village has a dominant dry land rather than its rice fields. The research objectives are: analyzing soil quality from physical, chemical and biological aspects, knowing the limiting factors that cause low soil quality, determining management to improve soil quality so that productivity increases. The method used is a field survey and soil testing in the laboratory. The results showed that: average cation exchange capacity, base saturation, P_2O_5 and K_2O were low, and organic material was very low. Land management needs to be done to improve soil fertility, namely: application of phosphate-containing fertilizers, planting with intercropping, fertilizing with organic fertilizer using plant residues or cow dung or manure, making infiltration wells, and making holes to collect rainwater overcoming water obstacles.
***Keywords*:** evaluation, dry land, fertility

Introduction

The abundance of fertile irrigated land that has shifted functions into non-agricultural needs, because the increase in demographic population continues to grow, so the potential for dry land must be immediately developed for food crop cultivation. Broadly speaking, the potential for dry land in Indonesia is high, but there are biophysical and socio-economic problems that must be addressed to increase productivity in a sustainable manner. Several steps to overcome the limiting factors of soil biophysics by improving the management of soil fertility, conservation and rehabilitation of land, and efficient management of water resources and water use.

The development of dryland agriculture often faces various obstacles to increasing its productivity, so it needs to combine technology, which aims to improve or overcome these obstacles. Efforts can be made to improve the physical, chemical and biological properties of the soil by fertilizing and providing irrigation water. Land cultivated for agriculture has different fertility, so that proper land management is an important factor in determining the growth and results to be obtained. The nutrients needed by plants for growth and production are determined by the ability of the soil to provide nutrients for plants, but this cannot always be fulfilled. Intensive land use without crop rotation can cause depletion of important nutrients from the soil, so that soil fertility will continue to decline. Reduced soil fertility can be a major factor affecting soil productivity, so that the addition of nutrients in soil through fertilization is very important to obtain profitable agricultural production. (Erna Suryani and Ai Dariah, 2012). According to Abdurachman *et al.* (2005), the main constraint in the use of dry land in agriculture is the low soil fertility and this condition is further aggravated by the limited use of organic fertilizer, so it takes a good land management effort, meaning that fertilization in accordance with the needs for the type of plant cultivated. To formulate appropriate actions to achieve these objectives, it is necessary to know the level of soil fertility. Barriers to productivity on dry land are limited water availability during the dry season (Dwiratna, 2018). To find out the status of soil fertility can be done through a soil test approach where the assessment using this method is relatively faster and more accurate. The parameters analyzed are soil texture; Cation Exchange Capacity (CEC), Basic Saturation (BS), P, K, and content of organic matter. The results of the analysis in the laboratory are then compared with the criteria for fertility status based on guidelines from the Soil Research Center (1995), whether fertility status in the soil: very low, low, medium or high.

Based on this, research was carried out with the aim of knowing the status of soil fertility and what factors were the inhibitors, the decrease in soil quality and land productivity. The study was conducted in Sumberkima Village, an area that stretches from east to west, in the northern part of Sumberkima Village, which is directly adjacent to the water area with relatively narrow distances around 5 km from the coast to the mainland, with topography from flat to hilly. Sumberkima village has 25 hectares of rice fields and 702 ha of dry land. The average rainy season lasts 3-4 months (December-March), and the average dry season last 8-9 months (April-November). Land use is mixed cropping, dry land, shrubs, settlements, and forests (Central Statistics Agency, 2017). The research objectives are: analyzing soil quality in terms of physical, chemical and biological aspects, analyzing the limiting factors that cause low soil quality, determining the right direction of management to improve soil quality so that productivity increases.

Materials and Methods

Research location in Sumberkima Village, Gerokgak District, Buleleng Regency, Bali Province. Administrative boundaries: North: Java Sea; South: State Forest; East: Pemuteran Village and West: Pejarakan Village.

Materials

The materials used are: soil type map, land use map, slope map, and soil sample. The tools used: Global Positioning System (GPS) to determine the location of the research.

Methods

1. Restricting the location of the research, and mapping land units by overlaying the slope map, land type map, and land use map. Based on the map of land units, each soil unit is taken one soil sample, so that there are 25 soil samples which are analyzed for fertility, in Figure 1.
2. Soil samples analysis: physical, chemical and biological properties in Soil and Environmental Laboratory Faculty of Agriculture Udayana University, Denpasar, Bali, Indonesia.
3. The result of soil analysis is compared with the soil fertility criterion, so that the fertility status of the soil is obtained.
4. Data analysis by classifying soil fertility level according to soil fertility assessment criteria according to the Center of Soil Research (1995).

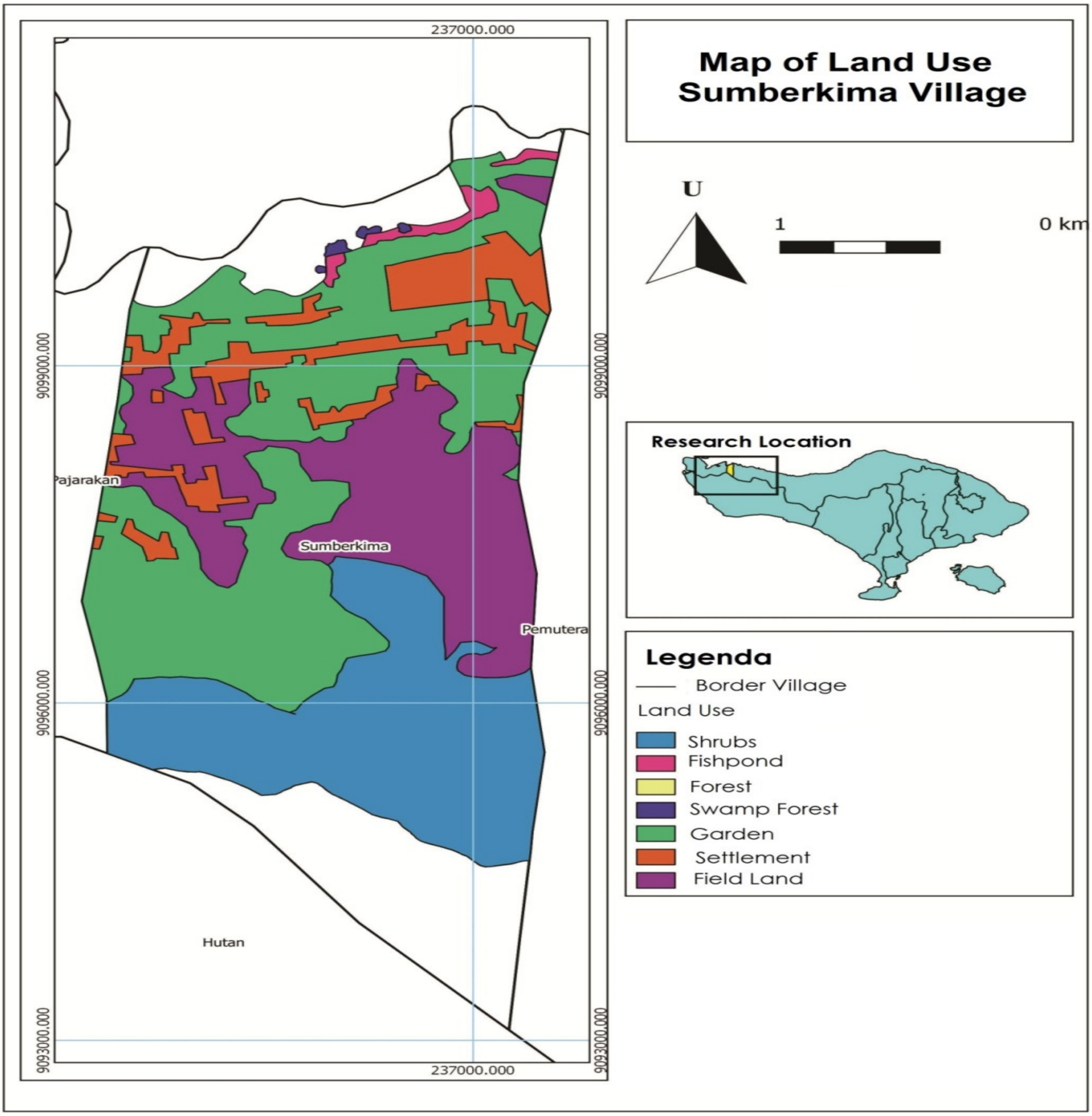

Fig. 1 : Map of Land Use in Sumberkima Village

Results and Discussion

Soil fertility evaluation is the process of soil assessment, and the results of its evaluation of fertility can be used for fertilizer recommendations. According to Sys *et al.* (1993), soil fertility or soil quality can play a positive role if it is profitable and may be negative if it is an inhibiting factor for land use. The results of field observations and results of soil analysis in the laboratory are presented in Table 1. Evaluation of soil fertility is the process of soil assessment, and the results of the evaluation of fertility can be used for fertilizer recommendations. According to Sys *et al.* (1993), soil fertility or soil quality can play a positive role if it is profitable and may be negative if it is an inhibiting factor for land use. The results of field observations and results of soil analysis in the laboratory are presented in Table 1.

Table 1 : Result of analysis soil physical, chemical and biological properties in Sumberkima Village

No	Land use	Texture	pH	CEC (me/100g)	BS (%)	P_2O_5 (ppm)	K_2O (ppm)	Organic matter (%)
1	MC	CL	6.5 N	15.00 L	21.61 L	13.66 L	24.30 M	1.57 L
3	Dry land	CL	6.6 N	12.31 L	26.21 L	16.56 L	29.87 M	1.60 L
4	Bush	CL	6.5 N	7.20 L	15.21 VL	10.75 L	10.75 L	0.95 VL
5	Forest	CL	6.5 N	16.93M	30.41 L	12.02 L	34.98 M	2.57 M
6	MC	CL	6.5 N	14.76 L	20.85 L	13.66 L	21.18 M	1.27 L
7	Bush	CL	6.6 N	4.72 VL	12.73 VL	9.04 VL	9.15 VL	0.89 VL
8	MC	CL	6.5 N	6.74 L	22.89 L	11.42 L	27.12 M	1.52 L
10	Dry land	CL	6.5 N	13.74 L	28.89 L	12.32 L	31.18 M	1.81 L
11	Bush	CL	6.7 N	4.57 VL	17.76 VL	8.12 VL	8.23 VL	0.82 VL
12	Forest	CL	6.8 N	17.28 M	29.98 L	16.90 L	29.11 L	0.68 VL
13	MC	CL	6.6 N	14.20 L	20.65 L	15.11 L	39.12 M	1.57 L
15	Dry land	CL	6.5 N	13.31 L	20.63 L	14.12 L	24.45 M	1.23 L
18	MC	CL	6.7 N	12.68 L	28.22 L	14.98 L	26.29 M	1.41 L
20	Dry land	CL	6.5 N	10.31 L	29.31 L	12.04 L	31.01 M	1.15 VL
21	Bush	CL	6.7 N	5.06 VL	17.76 VL	9.66 VL	5.71 VL	0.91 VL
22	Forest	CL	6.7 N	15.50M	29.00 L	16.96 L	27.12 M	1.81 VL
23	MC	CL	6.8 N	11.32L	21.79 L	11.08 L	19.13 M	1.52 VL
24	Dry land	CL	6.7 N	9.31 L	20.88 L	14.23 L	23.14 M	1.35 VL
25	Bush	CL	6.8 N	5.09 VL	15.17 VL	5.21 VL	9.15 VL	0.87 VL

The soil at the study site is a type of latosol or inceptisol soil, soil that has a thick solum layer. Soil texture is the percentage ratio between the content of sand, dust and clay. The texture of the soil in the study area is rather smooth (dusty clay). Soil pH in the study area is near neutral, which means that soil pH is not an inhibiting factor for plant growth and development, even though the study site is close to the coast. The value of cation exchange capacity (CEC) is very low until moderate. Base Saturation (BS) is the ratio between the number of base cations exchanged and the soil cation exchange (CFC) exchange capacity expressed in percent. Land in the study site has a low average base saturation, because the value of the CEC is usually directly proportional to the saturation of the base of the soil (Sukisno *et al.*, 2011). The results of measurements of soil phosphate levels (P_2O_5) from each land use are on average low, because there is a crop yield, less fertilization so that the availability of P will be thinner. The amount of phosphate in the soil varies greatly depending on the type of soil (Handayanto and Hairiyah, 2007). Element P in the soil comes from chemical fertilizers (TSP) (Hardjowigeno, 2003). The results of measurements of soil potassium (K2O) available in each land use are moderate. Potassium is available to accumulate in the soil because there is no leaching so that in soil K is classified as moderate (Foth, 1994). Organic matter is very low, due to low vegetation cover and high evapotranspiration so that many of the missing elements evaporate from the soil, without adequate nutrition returning to the soil. Lack of organic matter can affect the availability of organic matter in the soil. Low organic matter content means low soil fertility, because soil organic matter is one of the parameters that determine soil fertility (Musthofa, 2007).

Plant nutrition for growth and production is determined by the ability of the soil to provide nutrients for plants, but this condition cannot always be fulfilled. Intensive land use without crop rotation or intercropping systems and lack of organic fertilizers, causes a reduction in important nutrients from the soil, so that soil fertility will continue to decline. Reduced soil fertility can be a major factor affecting soil productivity, so the addition of nutrients in the soil through a fertilization process is very important to do to obtain profitable agricultural production.

Soil fertility status is a condition of soil fertility at a certain time. Evaluation of soil fertility is carried out to assess, and monitor soil fertility, and it is very important to determine the nutrient content available in the soil and the factors that inhibit plant growth. Evaluation of soil fertility can be done through a soil test approach in the laboratory, because the assessment using this method is relatively more accurate and fast. Measurements of soil physical, chemical and biological properties as soil fertility parameters were then compared in soil fertility criteria by the Center of Soil Research (1995).

Based on the results of soil analysis in Table 1, the level of soil fertility in Sumberkima Village is categorized as low, because organic matter are low, the causes of which are minim cover crops and high evaporation because the area has low rainfall. To prove that the area has low rainfall , farmer planting (palawija crops), nearing the end of the rainy season, to overcome the difficulties of irrigation water. This situation can be seen, the use of dominant dry land (dry land, mixed cropping, and plantations) covering an area of 702 ha, while for rice fields only 25 ha. To overcome this condition or increase the level of soil fertility, land management needs to be done by providing organic fertilizer, by adding organic materials such as: manure and using the remaining compost so that soil fertility can be maintained properly, production and quality of soil maintained. Musthofa (2007) in his research stated that the content of organic matter in the form of organic matter in the soil must be maintained at no less than 2 percent. Provision of organic fertilizer at the time of absolute soil management so that the content of organic matter in the soil does not diminish over time due to the process of decomposition of mineralization. Fertile soil has sufficient nutrient availability for plant growth Poerwowidodo (1992) and Utomo (2002).

Conservation with tillage, and addition of organic matter, can maintain soil health, plant growth, and the environment (Surinder Singh Kukal *et al.*, 2015).

Applications of synthetic fertilizers such as Urea and Diammonium Phosphate (DAP) are clearly important strategies to reduce nutrient depletion, and cause the P content in the soil to increase significantly (Yang *et al.*, 2016). However, fertilizer alone cannot guarantee long-term sustainable productivity for several reasons such as financial pressures and sustainability issues. Therefore, input of organic material is needed to maintain organic soil. The transfer of nutrients and energy from the biological components of life to the soil is closely related to the fall of litter and is the starting point for the nutrient cycle. The fall of litter is a major part of the nutrient cycle between plants and soil (Kassaye Gurebiyaw, 2019). Linking the nature of microbial soils to plant productivity is important to appreciate the value of microbial activity of soil in sustainable agriculture. Conservation practices include the addition of compost cow manure; rotation of various plants and use of cover crops is important compared to conventional management systems that do not have conservation practices. Good land management can increase land productivity (Linsler *et al.*, 2016). The results of Lupwayi's study (2018) and (Tolera Abera, 2018) said that the relationship of microbial biomass carbon with wheat yields averaged over 10 years, with conservation management . This means that the use of integrated sources of organic and inorganic fertilizers (N, P and K) significantly increases yields and yield components. Sustainable agriculture tends to reduce the use of organic fertilizers and pesticides, but relies more on crop rotation, crop residues, animal manure, green manure, legumes, or minimal tillage (Chizari, 2009).

Sumberkima village has obstacles in its land use, in addition to the low nutrition content (P, K and organic matter) it also has low rainfall (1544 mm/year). To overcome this problem, by making cubang, to overcome water shortages during planting, make infiltration wells, because the sustainability of crop production is determined by soil fertility and also the availability of irrigation water. Saving irrigation water can be done by intercropping or crop rotation and mulching or planting cover crops. According with the Dwiratna (2018), good management is crucial for obtaining high returns from a production system on a sustained basis. Therefore, it is essential that farmers and extension personnel are made aware of local resources for developing the managerial ability of farmers to cope with new demands, new problems and new challenges.

Conclusions

The results showed that: Average CEC, BS, P_2O_5 and K_2O were low until medium, and organic matter average low. Overcoming this, land management to improve soil fertility is: adding organic matter with compost or manure, mulch using plant residues, or planting crop cover crops and intercropping cropping patterns. Production is obtained optimally if soil fertility and climate factors are not obstacles. To overcome the availability of irrigation water due to low rainfall is by making well infiltration and *cubang* (a place like a tub of water to storing rainwater).

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References

Abdurachman, A.; Umi H. and Ishak, J. (2005). Determination of Soil Water Content by Method of Soil Research Institute - Agricultural Research and Development Agency. 2009. Dry Land Test Kit. Agriculture Department. Great Research and Development of Agricultural Land Resources.

Chizari, M. and Ommani, A.R. (2009). The Analysis of Dry Land Sustainability. Journal of Sustainable Agriculture. Vol 33(8).

Dwiratna, S.; Bafdal, N.; Asdak, C. and Karsono, N. (2018). Study of Runoff Farming System to Improve Dryland Cropping Index in Indonesia. International Journal on Advanced Science, Engineering and Information Technology. Vol 8(2).

Erna, S. and Ai, D. (2012). Increased Soil Productivity Through the Agroforestry System. Journal of Land Resources. Vol 6(2).

Foth, H.D. and Turk, L.N. (1999). Fundamentals of Soil Science, Fifth Ed. JohnWaley & Sons, New York. Gravimetric. In: Kurnia, U. (eds.). Soil Physical Properties and Analysis Methods.

Handayanto, E. and Hairiyah, K. (2007). Soil Biology The Foundation of Healthy Soil Management. Adipura Library.

Hardjowigeno, S. (2003). Soil Science. Akademika Pressindo, Jakarta.

Kassaye, G.; Abay, G. and Melese, Y. (2019). Soil Physical Properties Enhancement via Native Tree Species in Northern Ethiopia. Journal of Advances in Agriculture Vol 10(1).

Linsler, D.; Kaiser, M.; Andruschkewitsch, R.; Piegholdt, C. and Ludwig, B. (2016). Effects of cover crop growth and decomposition on the distribution of aggregate size fractions and soil microbial carbon dynamics. Journal Soil Use and Management. Vol 32(2)

Lupwayi, Newton Z, Larney, Francis J, Blackshaw, Robert E, Pearson, Drusilla C, Eastman, and Andrea (2018). Soil Microbial Biomass and Its Relationship With Yields of Irrigated Wheat Under Long-term Conservation Management. Soil Science. Vol 183(5)

Mustofa, A. (2007). Changes in physical, chemical and biological properties of soils in natural forests converted to agricultural land in the Gunungleuser national park. [sripsi]. Bobor: Faculty of Forestry Institute Pertanian Bogor Agricultural Development. Ministry of Agriculture, Bogor. Pg. 131-142.

Poerwowidodo (1992). Study of Soil Fertility. Bandung.

Soil Research Center (1995). Technical Guidelines for Soil Fertility Evaluation. Technical Report No.14. Version 1.0.1. REP II Project, CSAR, Bogor.

Sukisno, K.S.; Hindarto, H. and Wicaksono, A.H. (2011). Potential Mapping and Soil Damage Status to Support Biomass Productivity in Lebong District. Soil Science Program, Faculty of Agriculture UNIB.

Surinder, S.K.; Kaur, B.A.; Bhattb, B.R. and Ashura, A.D. (2015). Conservation tillage impacts on soil, crop and the environment. International Soil and Water Conservation Research, Vol 5(2).

Tolera, A.; Tolcha, T.; Tesfaye, M.; Haji, K. and Buzuayehu, T. (2018). Effect of Integrated Inorganic and Organic Fertilizers on Yield and Yield Components of Barley in Liben Jawi District. International Journal of Agronomy. Vol 20 (1).

Utomo, M. (2002). Management of dry land for sustainable agriculture. Paper in the workshop on the core curriculum of the Faculty of Agriculture in Indonesia. Mataram-NTB, May 26-28, 2002

Prabowo, R. and Subantoro, R. (2018). Soil analysis as an indicator of fertility levels. land of agricultural culture in Semarang city. Scholarly Scientific Journal. Vol 2 (2).

Wahyu, A.N.; Sudjono, U.; dan, W.S. (2011). Paddy Soil Quality Management Modeling in District of Jatipuro, Karanganyar Regency. Soil Sains – Journal of Soil Science and Agroclimatology Vol 8. (1).

Yang, X.; Zhuang, L.I. and Cheng, C. (2016). Effect of Conservation Tillage Practices on Soil Phosphorus Nutrition in an Apple Orchard. Horticultural Plant Journal. Vol 2. (1).