Land suitability evaluation of crops that form agroforestry in Tanralili district Maros regency

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Abstract. In Maros Regency, especially Tanralili District, some people do not only farm on paddy fields, but also on land planted with trees, such as gardens in the yard, commonly called agroforestry. This study aims to decide land suitability classes for agricultural and forestry, and analyze limiting factors in developing agroforestry in Tanralili District. The methods used in this study were land survey, soil sampling, laboratory analysis, and matching methods to evaluate land capacity and land suitability for peanut and sengon in 10 land units from work maps. The results of this study show that land capability classes in Tanralili that can be pursued for agroforestry systems are class III and IV, with limiting factors such as slopes, erosion, rocks, soil texture, and rooting condition in sub-class III, and drainage factor in sub-class IV. The actual land suitability class for Peanut is S3 (marginally suitable) and class N (unsuitable), and for Sengon is S2 (moderately suitable), S3 (marginally suitable) and N1 (unsuitable for now). The threat of erosion is a limiting factor that can inhibit optimal growth of peanut and sengon. Nutrition availability affects inhibition of peanut. Water availability and the rooting condition and land preparation becomes limiting factors for Sengon.

1. Introduction

Some people do not only farm on paddy fields, but also on land planted with trees, for example gardens in their yards in Maros Regency, especially in Tanralili District. They use the land under the trees to cultivate various kinds of agricultural crops, such as galangal, pineapple, sweet potatoes, and others in an area, or commonly called the agroforestry system. In Tanralili, most of farmers have practiced agroforestry since 90s on land that was originally planted with only trees. Then, they made use of the land under the trees by cultivating seasonal crops. This is due to the preferences of the people in Tanralili based on economic, social and external factors to implement an agroforestry cropping system [1]. In Tanralili Subdistrict, crops that were cultivated the most for agroforestry are peanuts and sengon. However, the productivity is still low. Because Tanralili District has areas with various slope classes, this factor makes the commodities must be considered to be chosen, for example peanuts that are more optimal in flat areas [2].

In agroforestry practice, the combination of commodities are expected to provide positive interactions and adaptations. One method that can be used in determining the selection of plant species is the naturalist method. The naturalist method is a method used by adjusting the growth requirements of a plant with the characteristics of the land in the development location [3]. This is inseparable from
the role of humans interaction with other agroforestry components in land management, such as abiotic environment (water, climate, nutrients, topography and climate), and biotic environment, such as woody and non-woody plants [4]. Therefore, it is necessary to evaluate the suitability of land classes for crops that form agroforestry system.

2. Materials and methods

2.1. Location and methods

This research was conducted in Tanralili District, Maros Regency. The type of research is qualitative (focusing on biophysical analysis for land suitability), with a simple limiting factor approach.

2.2. Method of collecting data

Preparation and collection of secondary data was carried out through making work maps by overlaying maps, such as maps of soil types, slope maps, geological maps, and land use maps to produce a map of land units. Furthermore, field observations were made to determine the condition of the land in the field. Then the determination of the soil sampling point is carried out in each unit of land which represents 10 of the 13 land units obtained from the map overlay. Due to the slope considerations in land units 11, 12, and 13, so the location of the sampling points are land units 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10. Next, data collection conducted by observing the location and taking soil samples in each land unit from the soil profile made with a size of 1 m × 1 m × 1 m.

2.3. Data analysis

Data analysis was carried out by analysing soil samples in the laboratory to determine soil characteristics, such as soil salinity, alkalinity, and soil pH, soil c-organic use the Walkley and Black method, soil texture use the Hydrometer method, cation exchange capacity (CEC) and base saturation, nutrients analysis N, P, K, and bases (Ca, Mg, Na, K). The determination of the land capability class is carried out by using a matching system method between the criteria for the land capability class and the soil characteristics obtained from the observation of the soil profile. Determination of land suitability class use matching system method between the characteristic data obtained from both, the observation of soil profiles and the results of analysis with the land characteristics of each commodity.

3. Results

3.1. Classification of land capability class

Table 1 shows the matching results between the characteristics of land at the location and the land capability grouping classifications. In each land unit in class III, there are erosion factors and rocks as barriers. The slope factor is also an inhibiting factor in land units 3 and 9, so that these two land units are included in sub-class III over. In land units 5 and 10, soil texture factor as a barrier, so it is classified into sub-class III teb. In land unit 7, not only erosion and rock are the obstacles, but also soil texture and effective depth, so that it is included in sub-class III tkeb. In land unit 8, soil texture, soil depth, slope, erosion, and rock become limiting factors, so it is included in sub-class III tkeb. In class IV, there is one land unit 6. The inhibiting factor is drainage, so it is included in the IVd sub-class. In class VI, there are three land units, land units 1, 2, and 13. Each land unit has a slope inhibiting factor, but in land units 1 and 2 there is also an erosion factor so that it is included in the VIIe sub-class, while the unit land 13 belongs to sub-class IVl. In class VII, there are three land units, land units 4, 11, and 12. All land units have slope as an inhibiting factor which are steep and very steep, so they are included in the VIIl sub-class. From the results of the classification of land capability classes, land units that included the class criteria and can be cultivated with agricultural and forestry crops are land units 3, 5, 6, 7, 8, 9, and 10.
Table 1. Inhibiting factors and the distribution of land capability classes in Tanralili District

| Land capability class | Land capability sub-class | Land unit | Limiting factor |
|-----------------------|---------------------------|-----------|-----------------|
| III                   | III leb                   | 3         | Slope; erosion; rocks |
|                       |                           | 9         | Slope; erosion; rocks |
|                       | III teb                   | 5         | Texture; erosion; rocks |
|                       |                           | 10        | Texture; erosion; rocks |
|                       | III tkeb                  | 7         | Texture; effective depth; erosion; rocks |
|                       | III tkleb                 | 8         | Texture; effective depth; slope; erosion; rocks |
| IV                    | IVd                       | 6         | Drainage |
| VI                    | VIe                       | 1         | Slope; Erosion |
|                       |                           | 2         | Slope; Erosion |
|                       | VI/                       | 13        | Slope |
| VII                   | VII/                      | 4         | Slope |
|                       |                           | 11        | Slope |
|                       |                           | 12        | Slope |

Note: l=slope; e=erosion; b=rocks; t=texture; d=drainage

3.2 Classification of land suitability class

Table 2 shows the actual land suitability classes for peanuts belong to class S3 (marginally suitable) and N (unsuitable) with their respective inhibiting factors. S3 class is divided into two sub-classes, S3na, eh and S3na. Meanwhile, class N has only one sub-class, Neh. Land units 3, 8, 9, and 10 are included in the sub-class S3na, eh with limiting factors for available nutrients and threats of erosion. Land units 5 and 7 belong to class S3na with nutrient availability limiting factors. Meanwhile, land unit 6 is in the Neh class with an inhibiting factor for the threat of erosion.

Table 2. Management of actual land suitability class into potential land suitability class with improvements to Peanuts

| Land unit | Actual class | Limiting factor | Improvement | Potential class |
|-----------|--------------|-----------------|-------------|-----------------|
| 3         | S3na,eh      | Nutrient availability | Fertilization, organic matter | S2wa,na,eh,lp |
|           |              | Erosion hazard   | Mulch, cultivation with hedgerow | |
| 8         | S3na,eh      | Nutrient availability | Fertilization, organic matter | S2wa,rc,na,eh,lp |
|           |              | Erosion hazard   | Mulch, cultivation with hedgerow | |
| 9         | S3na,eh      | Nutrient availability | Fertilization, organic matter | S2wa,na,eh,lp |
|           |              | Erosion hazard   | Mulch, cultivation with hedgerow | |
| 10        | S3na,eh      | Nutrient availability | Fertilization, organic matter | S2wa,rc,na,eh,lp |
|           |              | Erosion hazard   | Mulch, cultivation with hedgerow | |
| 5         | S3na         | Nutrient availability | Fertilization, organic matter | S2wa,rc,na,lp |
| 7         | S3na         | Nutrient availability | Fertilization, organic matter | S2wa,rc,na |
| 6         | Neh          | Nutrient availability | Mulch, cultivation with hedgerow | S3oa,eh |

Note: na= nutrient availability; eh=erosion hazard; lp=land preparation; wa=water availability; rc=rooting conditions; oa=oxygen availability; eh=erosion hazard

Table 3 shows that land suitability classes for Sengon are divided into three classes, S2 (sufficiently suitable), S3 (according to marginal) and N1 (currently unsuitable) with each inhibiting factor dividing the class into sub-classes. Land units 10 are included in the S2wrpe sub-class with inhibiting factors such as water availability, rooting media, land preparation and erosion. Land units 3 and 9 are included in the S2wrpe sub-class with factors that inhibit water availability, land preparation, and erosion. Land units 8, 5 and 7 are included in the S3r sub-class with rooting media as inhibiting factor.
Table 3. Management of actual land suitability class into potential land suitability class with improvements to Sengon

| Land unit | Actual class | Limiting factor | Land suitability sub-class | Improvement | Potential class |
|-----------|--------------|-----------------|----------------------------|-------------|-----------------|
| 10        | S2wrpe       | Water availability | Irrigation system | -           | S2rp            |
|           |              | Rooting media    | -                       | Mulch, cultivation with alley cropping | S2rp |
|           |              | Land preparation | -                       | -           |                 |
| 3         | S2wpe        | Erosion hazard   | Irrigation system       | -           | S2p             |
|           |              | Water availability | -                       | Mulch, cultivation with alley cropping | S2p |
|           |              | Land preparation | -                       | -           |                 |
| 9         | S2wpe        | Erosion hazard   | Irrigation system       | -           | S2p             |
|           |              | Water availability | -                       | Mulch, cultivation with alley cropping | S2p |
|           |              | Land preparation | -                       | -           |                 |
| 5         | S3r          | Rooting media    | -                       | -           | S3r             |
| 7         | S3r          | Rooting media    | -                       | -           | S3r             |
| 8         | S3r          | Rooting media    | -                       | -           | S3r             |
| 6         | N1r          | Rooting media    | -                       | -           | N1r             |

Note: w=water; r=rooting; p=preparation of land; e=erosion hazard

4. Discussion

The use of sections to divide the text of the paper is optional and left as a decision for the author. Where the author wishes to divide the paper into sections the formatting shown in table 2 should be used. In this study, class III and class IV in land capability rule, agricultural cultivation can be applied but it is limited for selection of commodities because of heavy inhibiting factors and very careful management is needed [5]. Erosion factors and moderate surface rock are inhibiting factors for class III in each land unit. Also, there are factors of slopes, fine and slightly coarse soil texture, and shallow effective root depth. On land with steep slopes, an effort that can be used is rotating crops with cover crops or fodder. Whereas in class IV land there is only one unit of land with a drainage limiting factor which is often inundated. This can be improved by constructing drainage if it is to be used for agricultural business.

For class VI and class VII, because it has very heavy inhibiting factors, the land cannot be cultivated for agricultural, and only suitable for grazing, livestock grass, or forest. The inhibiting factors in class VI are very steep slopes and serious erosion hazards, while in class VII, there are steep slopes, with a slope of more than 45%.

As for land unit 6, there are heavy erosion inhibiting factors. Efforts that can be made to reduce the danger of erosion are suggested to carry out planting along contour lines or making ridges. The mounds function to increase the absorption of water into the soil and hold the surface flow rate by draining water from the cultivated field [6]. In land units 5 and 6 there are inhibiting factors, such as oxygen availability associated with soil drainage. This factor cannot be improved so that in land units 5 and 6 only improvements to reduce limiting factors such as water availability, nutrients, and erosion. However, the class of the two land units cannot increase and only a reduction of factors occurs. the barrier so that the land suitability class becomes S3oa. Whereas in land units 3, 8, 7, 9, and 10, by making improvements, the land suitability class in the land unit can be increased to S2 class with each limiting factor.

For land suitability classes of peanuts, there are only two limiting factors in each land unit, such as nutrients availability and the threat of erosion. Peanut require sufficient nutrients for optimal production. The nutrient content of Potassium in that location is very low, while peanuts require high
potassium content which plays a role in plant metabolism [7]. Efforts that can be made to increase the potassium content in the soil are K fertilizer or organic matter.

The threat of erosion in land units 3, 8, 9, and 10 is considered light, and in land units 6 is heavy. For good peanut growth, it is best if on cultivated land there is no threat of erosion or very light level of erosion [8], for example in flat areas. However, on land with moderate to severe levels of erosion, the peanut cropping pattern can be adjusted by assuming alley cropping concept with hedgerow. One of the tall hedgerows that can be used is the Sengon tree [9]. The combination of peanut and sengon plants is an application of agroforestry as a cover crop that can reduce erosion during the rainy season because it can prevent damage to soil aggregation [10]. After it is assumed that there are efforts to improve, the land suitability class of land units 3, 5, 7, 8, 9, and 10 increases to S2 class, while land unit 6 increases to S3.

The land suitability classes for Sengon in land units 10, 9, and 3 are quite suitable, but have a limiting factor, it is water availability related to annual rainfall. This can be done by making trenches to reduce excess surface water during the rainy season. In addition, the limiting factor for erosion is still relatively light in land units 10 and 9. However, Sengon is more suitable for growing in areas with very light levels of erosion or no threat of erosion [11].

The slope factor which is inhibiting in land unit 3 is classified as a slightly slope class around 8% - 15%. Sengon can grow optimally in areas with slopes below 8% [12]. In flat areas the threat of erosion is not severe, which can affect soil solum and organic matter content in the top layer [13], so that the nutrient content needed by plants can decrease. This can be pursued by improving land, for example the application of live mulch, such as ground cover crops, namely peanuts, because these plants can reduce erosion rates by covering the soil surface so as to prevent rainwater collisions that damage soil aggregates [2]. In addition, alley cropping or alley cropping systems can be applied by planting live mulch or peanut plants between the rows of Sengon plants. In addition, in land units 10, 5, 7, 8, and 6, there are inhibiting factors for rooting media. This factor cannot be described as an effort to improve. The limiting factors for land preparation related to surface rocks and rock outcrops [14]. The Sengon land suitability class did not increase, but only experienced a reduction in the limiting factor with improvement.

5. Conclusion
We conclude that the land capability classes in Tanralili District that can be applied for agroforestry system are class III and IV, with limiting factors in each sub-class III are slope, erosion, surface rock, soil texture, and effective depth, meanwhile drainage factor in sub-class IV. The actual land suitability class for peanuts is S3 (marginally suitable) and class N (not suitable). Whereas for Sengon it is S2 (moderately suitable), S3 (marginally suitable) and N1 (unsuitable for now). Limiting factors for peanuts are nutrients availability and erosion. As for sengon are availability of water, rooting media, land preparation, and erosion factor.

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