

Optimalization of Space Grows Vertically and Horizontally Based on Local Community Knowledge

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Abstract. Increasing land productivity might be achieved by managing land resources efficiently and effectively. It might be realized on vertical and horizontal space utilization over a plot of land, with integrated land use approaches. This study assesses the utilization of vertical space and horizontal space on community land and its minimum production. The community land use in the form of agroforestry (simple and complex) and mixed plantations, vertically of arranged in two to four strata and Horizontally the distribution of plants covering almost all the space or land. The minimum vertical and horizontal space utilization in the two canopy stratum has been could increased the land productivity, It can be better when considering the availabe of growth spaces especially vertical and horizontal space as well as ecological interaction of each combined plant species.

Keywords : Optimalization, Vertical Space, Horizontal Space

1. Introduction

The largest challenge of the agricultural sector in the fulfillment of community food today is the scarcity of land resources due to the conversion of productive land to non-farming massively [1]. In the meantime, the carrying capacity of remaining agricultural land has largely decreased, especially the decline in soil fertility due to the use of chemical fertilizers with high concentrations and doses over a long period of time continuously [2]. In addition, limited land has put pressure on forest resources. This is because forests are looked at as land reserves that are ready to be exploited at any time to meet the demands of agricultural land expansion.

Indeed food stuffs might be produced without cutting the forest through the use of annual crops-based on dry land that are commonly found on homegarden, garden, cash crop plantation, mixcropping, and agroforesry [3]. In general, these land uses utilize the growing space above 1.5 m, so there is an empty space under the plants.

Utilization of agricultural land, especially dry land through vertical and horizontal space arrangements for food needs has not been noticed by various stakeholders including the main actors of the agricultural sector and other stakeholders, namely employers and governments. Arrangement of vertical spaces and horizontal spaces over a plot of land, with an integral approach to land use (time, crop-specific, and upper space aspects) through crop management is a manifestation of the efficiency and effectiveness of land resources. This is expected to be an alternative solution to the scarcity of potential land for agricultural production as well as increased land productivity.

By knowing vertical and horizontal spaces of a land unit, it could be a basis for enrichment or other treatment of farming system. The benefits of knowing the vertical and horizontal spaces such as the canopy density distribution, the complexity and dominance of plants, the plant species combinations, it is taking into consideration in undertaking pruning and thinning, the percentage of distribution area between plant combination, the unit area, the percentage of land cover, the open area and potentially conducting planting enrichment as well as the basis for consideration of land management in the future [4].

The concept of vertical and horizontal space utilization refers to the natural condition of the existence of forest resources with various plant species arranged in such a manner in the order of structure and composition that build up an association. This condition provides a natural awareness that land resource management technologies should be designed in a landscape system with a variety of species. Thus, the monoculture land resources management becomes a necessity that must be narrowed down. This idea is not new but it is something that we would like to refine again so that the food crisis caused by the land resource crisis could be minimized. Certainly the crisis in question is on the causes of aridity on the land resources management that are low in food crop species diversity.

Based on the above conditions, research on utilization of horizontal space and vertical space in community farming system, especially perennial crop base is important to conduct. Therefore, the objective of this research is to study the vertical space and horizontal space utilization on community land based on local knowledge as a manifestation of efficiency and effectiveness of land resources toward a sustainable agriculture management in order to food security.

2. Methodology

The research was conducted on the farmland of community in Nokilalaki sub district, Sigi Regency. Data were collected through observation and interview. The land use forms are directly observed in the field. Further information on perennials and seasonal crops yield was obtained through in-depth interviews with 36 respondents. The respondents were purposively sampled with considering the respondents cultivate perennials and seasonal crops in mixture. Data were analyzed descriptively qualitative. Qualitative descriptive analysis is used to explain the forms of community land use.

3. Result and Discussion

3.1. Horizontal Space and Vertical Space Utilization Based on Local Community Knowledge.

Land use is any form of human intervention to the land, both permanently and temporarily in the context of fulfilling its needs. The level of human interaction with land resources is influenced by a complex factors of physical, biological, social, political and economic dimensions of space and time [5]. The community's dependence on land resources is usually feared to threaten over-utilization and degradation, so it is expected that land use requires more effective management systems. Based on the results of the study found three main forms of land use Nokilalaki community are: simple Agroforestry, complex agroforestry and mixed garden, presented in Figure 1.

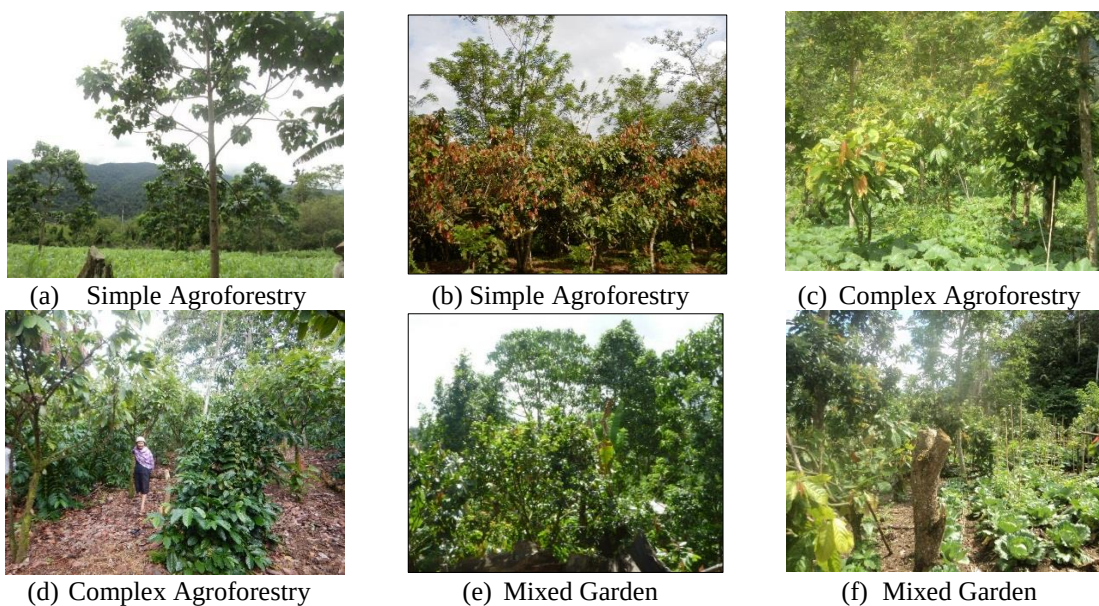


Figure 1. Community Land Use

The planned form of land use in the expectation of interaction of combined crops is called agroforestry, while unplanned plant combinations are not based on the needs and dependence of each plant but only on the availability of space and seeds for planting called mixed plantations. This means that not all cropping systems that combine various commodities on a land unit will always be called agroforestry.

Agroforestry focuses on deliberate combinations of agricultural and forestry crops, the purpose of combining and interacting so that not all combinations of forest, agriculture or animal components can be regarded as agroforestry [7].

Vegetation structure in agroforestry can be seen based on the composition and combination of types of constituent components in space and time. The structure of the agroforestry compilers and the community mixed garden is unevenly distributed, arranged in two to four strata on the tendency of various types of plant combinations to exist with a variety of benefit functions or management objectives. The Stratum is; stratum I (<1.5 m) is formed from a combination of food crops, vegetables and herbs or medicines. Stratum II (> 1.5–5 m) is composed of cocoa, coffee, banana, and at Stratum III plants (> 5-10 m) formed from a combination of fruit species (aren, rambutan, avocado). Whereas IV stratum (> 10 m) is formed from a combination of candlenut and durian plants.

Horizontally, land cover from the distribution of plant species includes almost all existing space or land. The use of horizontal space in the community still opens up opportunities for improvement. This will continue to change over time and the progress of agricultural technology applied.

3.2. Improving Land Productivity Through Growth Spaces Optimization

Utilization of space a land unit is an attempt to optimize the vertical space and horizontal space with various crops species on both agricultural commodities, forestry, plantations, medicinal plants and others. Knowledge in spatial arrangements taking into consideration the forms of plant growth, canopy coverage and combined plant root systems will reduce competition for nutrients, water and sunlight [4].

The concept of setting the space on a practical level in the field will lead to a combination system of plants to be cultivated by taking into account the available time, available vertical and horizontal spaces. The vertical combination will result in different plant structures and different height, which will form a canopy layers or canopy stratum. This provides an opportunity for selection of species combinations based on architectural form of the tree canopy (round, cone, cylinder) and the plant's physiological response to sunlight (CAM, C3, C4). Whereas the horizontal space will be separately showed by growing space based on the crop species arranged in a particular pattern and a certain spacing as well.

Plant species combinations have a positive impact on the production level. This could be looked from the results of land use optimise observation that combining perennials (candlenuts) with seasonal crops (maize) indicates that the presence of candlenut reduces the growth space for maize by 54% thereby decreasing the productivity of maize by 33%-46% compared to monoculture system. The decrease in maize productivity is not only influenced by the reduction of growing space but is also influenced by the physiological response of maize crop as C4 plant or plants that do not need shade. The presence of maize crops among the candlenuts increased the productivity of candlenuts by 2.5%-5.3%. This occurs because the maintenance activities of maize, especially fertilization, irrigation and weed controls have a positive effect on candlenuts.

The reduction of maize yield is replaced by the addition of land productivity in the presence of trees by 44% -56%. This means that changing the system of cultivation of plants from monoculture to poly culture through spatial arrangement could increase the land productivity. The condition will be better with the right selection of plant species combination.

Other efforts that could be done in order to optimise land use that is changing the spacing of trees, especially candlenut monoculture (10m x 10m) to 6m x 16m and 8m x 12m in the combination system might increase the number of individual trees per hectare by 4%. While the presence of trees in a seasonal crop could decrease maize population by 54% of the maize population. Setting the spacing by reducing the distance in the row and widening the distance between the rows to give space for the

seasonal crops could actually increase the number of candlenut per hectare. Whereas the annual crop population reduction occurred due to the growing space in the monoculture system is occupied by maize, at the combination system growing space is used by candle nut trees.

The presence of trees in vegetable crops might reduce the vegetable growing space by 24% -42%, and reduce the vegetable yield by 23% -26%. On the other hand, the presence of vegetable crops might increase tree productivity 3% -10%, finally land productivity might increased 56% -58% [8].

4. Conclusion

The community land uses consist of three: simple Agroforestry, complex agroforestry and mixed garden, where the selection of crop species combination and crop rotation is based on optimizing the growing space. The minimum vertical and horizontal space utilization with the two canopy stratum of crops could increase the land productivity by 44% -56%. Efficiency and effectiveness of land resource utilization would be better if considering the available of growth spaces especially vertical and horizontal space as well as ecological interaction of each combined plant species.

Acknowledgments

Thank's to The Directorate of Research and Community Service, Directorate General of Research and Development Strengthening, Ministry of Research, Technology and Higher Education has funded this research. Thank you all the enumerators for their contributions in data collection. Thank you to Mr. Udin, SP., MP for the motivation, support and narration during research activities until the completion of this simple writing.

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