Feasibility analysis of hedgerow agricultural based on mangosteen plants

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Abstract. This research aimed to determine the feasibility analysis of a farming mangosteen-based on the hedgerow farming systems. The research was conducted in Tanah Karaeng Bili-bili Village, Manuju Sub-District, Gowa Regency, South Sulawesi Province. The research was designed using a Randomized Block Design (RBD) with four different treatments. Financial analysis was applied to the data on maize, stover production, and biomass, which were obtained in one harvest season. While productivity data obtained by assuming that this treatment carried out intensively, three times a year. As a result, the treatment of mangosteen hedgerow, gamal, maize, and miscanthus (P1) farming systems, mangosteen hedgerow farming systems, gamal, corn, and setaria (P2), mangosteen hedgerow, gamal, corn, and elephant grass systems (P3) at the beginning of farming years 1-6 have made a great benefit. The highest revenue obtained from the P3 treatment and the lowest one from the control treatment of P0 (mangosteen hedgerow agriculture system, mamal, corn). This study proves that the integrated hedgerow farming systems could increase farmers’ income and very worthy of being applied to a marginal dry land, particularly in the skewed topography in the future.

1. Introduction
The current agricultural development program directed at developing competitive, robust, decentralized, and sustainable agricultural systems and businesses, which include the development of a reliable food security system based on diversity of food, culture, and local institutions [1]. Also accompanied by efforts to optimize and efficiency of the use of existing agricultural resources.

Almost all sectors of physical development require land. Dryland is one of the non-renewable natural resources, appropriate management of dry land-based on environmental insight. It is essential to deliver the achievements of the management of dryland agriculture that can improve the biophysical quality of the land and its productivity (sustainability of natural resources). Dryland development constrained by slope problems, hilly to mountainous undulating topography. Besides the slope problem, other factors are soil erosion sensitive, low soil fertility, so that land productivity is relatively low [2]. The importance of dryland management interpreted as an effort to maintain and improve soil fertility so that agricultural business can be sustainable without damaging environmental sustainability. Farming with hedgerows conservation technology is a farming practice by combining technical (mechanical) and biological (vegetative) conservation measures with seasonal spatial planning, annual plants, and legume plants for
conservation as well as producing fertilizer organic and forage fodder, as well as grass; by paying attention to the shape of the face and the characteristics of the landscape [3].

Hedgerow farming system is a development of the alley cropping system, one of the strategies in erosion control [4]. Vegetative conservation includes all actions that use plants (vegetation), both perennials that grow, bushes or shrubs, as well as trees and grasses and other plants intended to control surface runoff [5].

The hedgerow planting system with legume shrubs or trees is useful as a source of forage in fodder systems (cut and carry). This system can also reduce soil erosion and surface water flow [6,7] water infiltration and maintain soil moisture, improve soil structure, [8] add materials soil organic matter, can inhibit the spread of weeds [9] and can increase crop yields [10].

Farming patterns with hedgerows technology involving several types of plants will produce a mutually beneficial ecosystem, for example, residues or leaves taken from the hedgerows pruning, which can be used periodically as mulch or put into the soil as green fertilizer for annual crops. Pruning the green manure used as mulch will reduce soil moisture evaporation, control weeds, and stabilize the soil temperature of the rooting area to guarantee good plant root growth.

Maize cropping pattern on dry sloping land is recommended to use hedgerow cropping pattern (Alley cropping) by integrating food crops, annual and annual crops of legume, or feed grass. Corn plants have broad adaptations and are relatively easy to cultivate. About 79% of corn planted on dry land, 11% is on irrigated paddy fields, and 10% on rainfed lowland.

Planting of shrub legume species has widely used for food crops/forestry. In Malaysia, corn and beans would have better results if they planted between gliricidia, kalandra, and albizia plants. [11] reported that The optimal distance for the three legumes is 4 m in 2 runs. In the Philippines, of the three types of legumes (Desmodium rensonii, Desmanthus virgatus, and Flemingia macrophylla) that tried to planted among rice, apparently, F. macrophylla gave the best results on plant height and number of rice grains.

Breeders on dry land generally cultivate feed crops only as a reinforcing terrace plant or only planted on embankments. In dryland conditions that are generally sloped and prone to erosion, planting forage feed is not solely to produce forage but is also intended to stabilize the terrace and prevent erosion. Some research results in watersheds show that the effort to fulfill forage by planting grass on the edge of the terrace as an effort to maintain the terrace turned out to have a positive impact on animal feed production systems in addition to reducing erosion by up to 86.7% [10,11].

Planting terrace reinforcement plants in the form of legume trees and grass can provide tangible benefits to the farming system, including controlling erosion, improving soil fertility, and providing the animal feed. The benefits of terracing reinforcement plants planted tightly on terraced land in preventing soil erosion obtained from the retention of surface water runoff in the tillage fields, which diverted in a controlled manner through the drainage channels provided. In the developed terrace reinforcement system, organic matter in the soil and plant roots can increase the absorption of groundwater, thereby reducing soil erosion. Besides organic matter produced from crop pruning can increase soil fertility.

In previous studies in upland watersheds in the Central and East Java watersheds it found that sustainable management of hedgerows technology, in the long run, will bring comparative and competitive advantage value which includes: (a) control of soil loss and nutrients through erosion; (b) increasing biomass production through agricultural residues, planting legumes for conservation and land cover; (c) increase in organic production in "in situ"; (d) improvement of soil fertility status; (e) increasing grass production for fodder; (f) increasing yields of edible crops, crops, fruits, vegetables and timber; and (g) continuous increase in total farming yields.

Following the description, the interaction between corn plants and feed grass in the hedgerow planting system is something that needs to study in-depth.
2. Methods

2.1. Research approaches and types
This study was designed with a cropping system using a Randomized Block Design (RBD) consisting of two replications. The components of each treatment factor consist of a mangosteen-based hedgerow farming system in a dry land with the four treatments as follows:

P0 = Mangosteen Hedgerow Agriculture System + Gamal + Corn (control)
P1 = Mangosteen + Gamal + Corn + Hedgerow Agricultural System Mischantus grass
P2 = Mangosteen + Gamal + Corn Hedgerow Farming System + Setaria sphacelata grass
P3 = Mangosteen + Gamal + Corn Hedgerow Farming System + Elephant Grass

Mangosteen, gamal, and forage grass planted following a contour lines due to space efficiency considerations. Corn, as the main crop, planted between the rows of hedges. The planting area per treatment area is 20 m x 20 m. The space of pulut corn is 0.25 m x 1 m, while the distance of the hedgerows is 0.5 m so that there are five rows of corn plants in each corridor. Mangosteen plants planted with a distance of 10 m x 10 m, gamal is planted with a spacing of 0.50 m x 5 m while feed grass planted between the Gamal plants with a spacing of 0.3 m.

2.2. Location of the research
This research was conducted in the Village of Karaeng Bili land-Bili, Sub-district of Manuju, Gowa Regency, South Sulawesi Province. With a height of 16 m above sea level. Type of ground Mediterranean with undulating topography. The geographical location of the research site is at 05 ° 18 ' 00,5 ' 05 ° 18 ' 02,4 ' LS and 119 ° 36 ' 38,7 ' -119 ° 36 ' 44,0 ' E. Location of the research site is bordered by the Village of Moncong Loe in the North, the Village of Lemoa in the East, the Village of Tanah Karaeng in the West and South.

2.3. Analysis techniques
Production analysis uses an Analysis of Variance. Analysis of financial income for twenty years (assuming mangosteen crop productivity) by calculating Benefit Cost Ratio (B/C) and Net Present Value (NPV).

3. Results and Discussion

3.1. Farmers Business Feasibility Analysis
The financial analysis was applied to the data on maize, stover production, and biomass, which were obtained in one research harvest season. While the productivity data obtained by assuming that this treatment carried out intensively, three times a year. The cost analysis for mangosteen cultivation uses the assumption that the costs incurred for each treatment are the same. While the analysis of mangosteen production with the assumption of an area of 1 ha with a population of 100 trees for an inventory of 20 years by referring to the quality standards of mangosteen listed in the Indonesian National Standard SNI 01-3211-1992.

Table 1. The Average Investment Values, Costs, Revenues, and Benefits for each year in the various treatments of the hedgerow farming systems (Rp.th -1).

| Treatment | Investment | Cost  | Revenue | Profit        |
|-----------|------------|-------|---------|---------------|
| P 0       | 20,000,000 | 48,183,500 | 225,287,155 | 177,103,655   |
| P 1       | 23,333,335 | 46,401,000 | 247,731,261  | 201,330,261   |
| P 2       | 23,333,335 | 46,401,000 | 250,028,079  | 203,627,079   |
| P 3       | 23,333,335 | 48,253,500 | 267,118,469  | 218,864,969   |

Note: Analysis of Farming for 20 Years
3.1.1. Investment and operational costs

The investment costs in this research was the costs incurred at the beginning before the production plants, namely land rent, mangosteen seedling costs, gamal cuttings, grass seeds, and hedgerow manufacturing costs. Table 1 shows the analysis of the costs required from year 1 to year six planting in the mangosteen hedgerow, gamal, corn system without grass (P0) investment of Rp. 20,000,000. Whereas in the mangosteen hedgerow, gamal, corn, and miscanthus (P1) farming systems, mangosteen hedgerow farming systems, gamal, maize, and setaria grass (P2) and the mangosteen hedgerow farming system, gamal, corn and elephant grass (P3) require investment respectively Rp. 23,333,335. The investment value was higher because it required the cost of planting grass in the hedgerow farming system. After completing the 7th year until the 20th year, the investment costs for each treatment were the same as Rp. 28,000,000 for land rent.

3.1.2. Revenue

The revenue in this research was gained from the harvest of old corn, stover, gamal pruning, grass pruning, and mangosteen. The results of the study showed that the mangosteen hedgerow, gamal, maize and elephant grass (P3) farming systems produced the highest revenue, then the mangosteen hedgerow farming system, gamal, maize and setaria grass (P2) and the mangosteen hedgerow farming system, gamal, corn and elephant grass (P3) require investment respectively Rp. 23,333,335. The investment value was higher because it required the cost of planting grass in the hedgerow farming system. After completing the 7th year until the 20th year, the investment costs for each treatment were the same as Rp. 28,000,000 for land rent.
gamal, maize and miscanthus grass (P1). Whereas the mangosteen hedgerow, gamal, maize without grass (P0) farming systems received the lowest revenue compared to other treatments.

3.1.3. Profits

Figure 3 shows the benefit of each treatment P0, P1, P2, and P3. It shows that the hedgerow mangosteen, gamal, maize without grass (P0) farming system at the beginning of the 1-6 year planting year has not yet benefited, after entering the 7th year the new P0 treatment has benefited. In the treatment of mangosteen hedgerow, gamal, maize, and miscanthus grass (P1) farming systems, mangosteen hedgerow farming systems, gamal, corn and setaria grass (P2), mangosteen hedgerow, gamal, corn and elephant grass systems (P3) at the beginning of farming years 1-6 have made a profit. The most highest benefit obtained from the P3 treatment and the lowest one in the P0 treatment.

3.2 Benefit-Cost Ratio (B/C Ratio) and NPV

Table 2. The result of the financial analysis of the farming system in the various treatments.

| Treatments | B/C Ratio | NPV (Rp.) |
|------------|-----------|-----------|
| P 0        | 2.73      | 19,338,023|
| P 1        | 3.66      | 23,239,389|
| P 2        | 3.70      | 23,583,912|
| P 3        | 4.15      | 25,591,720|

Note: Analysis of the Farming Systems for 20 Years

The average Benefit Cost Ratio (B/C) in the mangosteen hedgerow, gamal, maize, and elephant grass (P3) farming systems was 4.15 and the lowest B/C in the mangosteen hedgerow farming system, Gamal, corn without grass (P0) of 2.73. While the Present Net Value (NPV) is directly proportional to the value of B/C, the highest value of the NPV is shown in the treatment of P3 (Rp. 25,591,720 to-1) and the lowest value is in the treatment of P0 (Rp. 19,338,023 to-1).
Figure 4. The Value of Benefit-Cost Ratio (B/C) for each treatment within 20 years.

Based on Figure 4, it shown that the treatment of P3, P2, P1 value of B/C > 1, which means it is feasible to develop from year 1 to year 20. While in the treatment of P0, the value of B/C <1 in the first year to the 6th year, after entering the 7th year to the 20th year, the value of B/C > 1.

Figure 5. The Net Present Value (NPV) for each treatment within 20 years.

Figure 5 shows the NPV value for each treatment. The treatment of mangosteen hedgerow, gamal, corn system without grass (P0) shows the NPV value in the first year to the sixth year negative NPV value, positive value in the 7th year to the 20th year. While the treatment of mangosteen hedgerow, gamal, maize and miscanthus (P1) farming systems, mangosteen hedgerow farming systems, gamal, maize and setaria grass (P2) and mangosteen hedgerow farming systems, gamal, maize and elephant grass (P3) have positive, positive NPV values during the period of the 1st year until the 20th year. Of all treatments, the highest NPV value was at treatment of P3.

4. Conclusion

The financial analysis of the feasibility of the best farming obtained in the hedgerow farming system of P3 treatment (mangosteen, gamal, corn, and elephant grass) with an average revenue of Rp. 267,118,469 to-1 and the benefit of Rp. 218,864,969 to-1, the Benefit-Cost Ratio is 4.15, and the Net Present Value (NPV) of Rp. 25,591,720 to-1 is positive, so it may be recommended to apply in a marginal dry land, particularly in the skewed topography in the future.
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