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To cite this article: N B Sukamdani and T Sukwika 2023 *IOP Conf. Ser.: Earth Environ. Sci.* **1133** 012061

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Erosion prevention through empowerment of human resources to support food security around the Kambaniru watershed, East Nusa Tenggara

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Abstract. The high activity of the community that is not accompanied by the readiness of human resources around the watershed determines the status of the land use index, the erosion index, and economic and social factors. The negative externality impacts arise due to unfriendly land-use management on various types of cultivation, including agriculture, cultivation, plantations, or even livestock, contributing to the potential for erosion. This study aims to create a causal model of erosion prevention through a human resource development approach to support community food security and develop a technical program for land rehabilitation around the Kambaniru watershed, East Nusa Tenggara. The research method is presented descriptively with observation, tabulation, and data valuation techniques. The performance assessment results of the Kambaniru watershed show a medium-category classification. Multi-purpose plants and trees are prioritized for land rehabilitation to prevent erosion and provide food security for the poor, such as corn and tubers. Human resource capacity development in the upstream and central communities has successfully supported the erosion prevention and land rehabilitation program. The policy implications of this research are as follows: the limited capacity of community human resources in land conservation can be started by socializing the planting of short-lived trees. The recommended species are legume family types that can thrive in various types of soil and are flexible with climate change. Corn and tubers are a source of high calories and nutrients needed to improve the quality of human resources in the Kambaniru watershed area. Therefore, developing a food reserve land program in the Kambaniru watershed is necessary.

1. Introduction

Forest village communities sufficient their daily needs by carrying out various activities in the Kambaniru Watershed (DAS). This watershed has an area of 140,440.70 hectares and is located in East Sumba Regency, East Nusa Tenggara. The Kambaniru watershed includes nine sub-districts, consisting of 34 villages and eight sub-districts. The Kambaniru dam uses water from this watershed to irrigate 1,540 hectares of rice fields [1].

Environmental degradation causes forest cover in watershed areas to decrease drastically. This condition is caused by the limited capacity of community human resources to manage and utilize land and forest resources. Freelancing farming systems, shifting ground, burning savanna during the dry

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season, and taking wood that is not balanced with replanting accelerate the rate of environmental degradation. This condition is exacerbated by limited access to capital support. The community, especially the poor, women, and vulnerable groups, ends up relying on forest products for a living because they do not have other business alternatives. During the last ten years, conditions in the Kambaniru watershed area have been quite alarming. In the dry season, the water discharge of the Kambaniru river decreases, but in the rainy season, it often overflows to inundate residential areas in certain places. The Kambaniru watershed is experiencing severe environmental degradation but continues to be rehabilitated [2]. Inland rehabilitation activities in the Kambaniru watershed area, there are short-lived plants. Calliandra (Calliandra calothyrsus) and Sengon (Albizia falcataria) plants are used for reforestation and preventing erosion. Both are tree plants from the leguminous family type that can thrive in various types of soil and are flexible with climate and climate change, according to [3]; [4]; [5].

The high activity of the community around the watershed sometimes also determines the poor land use index (IPL), erosion index, and economic and social factors. The negative external impacts arising from land-use activities that are not environmentally friendly in every type of cultivation, whether agriculture, cultivation, plantations or even livestock, contribute to the potential for erosion. The pattern of land management by farmers along the watershed is made traditionally. Generally, the location of these agricultural activities is on the river border with a moderate to steep slope, so the area has the potential to experience erosion [6, 7]. The land use pattern usually goes on for a long time from generation to generation to form a habit [8]. The slope class category around the Kambaniru watershed is dominated by the high steepness category (slope between 41-60%), with an area of 88,822 hectares (77.92%).

The slope of the land is prone to erosion, especially when the intensity of rainfall is high and vegetation cover is low. The probability of increasing decline is more elevated in line with the pressure on land use for agriculture, gardening, and grazing activities. The sensitivity of soil erosion on forest land, mixed gardens, dry fields, and shrubs along the watershed is generally on a slope [7]. It means the potential for a significant decline can occur if the land use activity gets more prominent and the hill is steeper. Ideally, agricultural business activities on sloping land should be terraced, so they are not prone to erosion [9]. The criteria for land slope, decay, and runoff threats in the Kambaniru watershed are categorized into three threats, namely low (3.34%), moderate (18.75%), and high (77.92%) [2].

Regarding land management in watersheds, the quality of human resources is closely related to behaviour in managing natural resources and the level of dependence on nature. The low rate of human resources causes the knowledge, capacity, and skills to manage natural resources to be quiet, thus having implications for decisions to use processes that can damage the environment. In addition, low human resources cause alternative employment opportunities to become limited and increasingly dependent on nature. As a result of this condition, critical land continues to increase from time to time.

Communities in the upstream and central areas along the Kambaniru watershed are dominated by the livelihoods of farmers (48%), ranchers (5%), fishermen (2%), and traders (4%), with the remaining 41% spread over livelihoods [1]. It shows that the quality of human resources is minimal and depends on nature. Meanwhile, there are more alternative livelihoods in the downstream area of the Kambaniru watershed. It shows that the human resources in the downstream region of the Kambaniru watershed are pretty good, and they are less dependent on nature to support their families.

Based on identifying the problems above, it is crucial to find a solution to prevent erosion of the Kambaniru watershed now and in the future. The effort is made by increasing the capacity of human resources through community empowerment. This study aims to create a causal model of erosion prevention through a human resource development approach to support community food security and develop a technical program for land rehabilitation around the Kambaniru watershed.

2. Methods

The data collected consisted of secondary data, including information on environmental issues and damage obtained through data collection and field observations, statistical data, observations, and related research results. The data collected relates to the conditions and problems of damage to land resources in the Kambaniru watershed, covering aspects of land and mineral resources, agriculture, plantations, livestock, and forestry. This data was obtained from relevant agencies in charge of forestry, agriculture, animal husbandry, and plantations.

The watershed performance is obtained based on the evaluation standard value by Minister of Forestry Regulation No. P. 61/Menhut-II/2014 concerning Monitoring and Watershed Management Evaluation. Performance appraisal is seen from various aspects and watershed performance indicators, including water management, land use, social, economic and institutional. For this study, the watershed performance assessment is based on vegetation cover and river water discharge indicators, as described in table 1.

Table 1. Watershed performance criteria and indicators

Criteria	Indicator	Parameter	Evaluation Standard	Description
Use land	Percentage closing by vegetation (PPV)	PPV= (LVP/WA)*100%	PPV > 80 (Very Good) 60< PPV 80 (Good) 40< PPV 60 (Fairly) 20< PPV 40 (Bad) PPV 20 (Very Bad)	LVP = Area vegetation permanent. WA = Watershed area.
Water management	Water discharge river	KRA = (Qmax/Qmin)	KRA<20 (Very Low) 20< KRA 50 (Low) 50< KRA 80 (Medium) 80< KRA 110 (High) KRA > 110 (Very High)	Q = River water discharge. KRA = Regime coefficient flow.

3. Result and discussion

3.1. Watershed performance assessment

Based on the Regulation of the Director-General of Land Rehabilitation and Social Forestry Number P. 61/Menhut-II/2014, the results of the evaluation of the performance of the Kambaniru Watershed are moderate. The results of the performance of the Kambaniru watershed in the "moderate" category are the average results of the evaluation of the water system output (water yield), which is in the "fairly good" category, and the value of the condition of the catchment area (DTA), which is in the "almost bad" category. The evaluation value of the water system output is "fairly good," meaning that not all indicators measured are categorized as good. The sedimentation rate indicator shows poor performance and is correlated with the value of "kinda bad" catchment conditions. Poor status indicators also occur in the land use index (IPL), land use capability (KPL), erosion index (IE or CxP), dependence on land (LQ), and land productivity (PL). The performance of the Kambaniru watershed is more emphasized in conditions that have never experienced drought and flooding, including the status of good water quality and low levels of water pollution.

The erosion value is strongly influenced by several indicators, such as rainfall, soil sensitivity, slope length, slope grade, land cover conditions, and conservation activities, as stated in the USLE formula. The analysis results show that the total erosion rate in the upstream area is 63,769,492.90 ha/ton/year. In contrast, in the middle region, the total erosion rate is 24,034,578.60 ha/ton/year, and in the downstream region, the total erosion rate is 24,034,578.60 ha/ton/year. 4,741,378.55 ha/ton/yr. The erosion index value in the upstream area of the watershed is 700.38%, the middle area is 489.02%, and the downstream area is 276.84%. Based on the classification level of the three river segments, the

score is bad, with a score of 5. Land cover and management factors, as well as conservation measures (CP), greatly affect the amount of erosion in the Kambaniru watershed. The CP value in the Upstream area of 0.554, the Middle of 0.633, and the Downstream of 0.547. All three have a score of 5 or are in the Poor classification.

The high sedimentation rate is caused by land cover and poor land suitability. In addition, it is influenced by the habitual patterns of people's behaviour so far. Economic conditions and the low level of welfare of the population will affect how land and water are used and managed around the Kambaniru watershed. The results of the performance assessment of the Kambaniru watershed have a score of 3.27 with a moderate classification value (table 2).

3.2. Human resources and pressure on land and forests (upstream, downstream)

Pressure and dependence on land and forests are often associated with community poverty. The same thing happened in the Kambaniru watershed area. Most of the population (> 50%) is below the poverty line. Based on the survey results in the field, the income level of the population per head of household (KK) living in the upper and central areas is, on average, USD 1–USD 1.5 per day. Downstream is USD 2 per day. Thus, most of the population in the Kambaniru watershed is categorized as poor at around USD 1.0–USD 2.0 per day.

Community poverty is generally caused by minimal natural resources and the low quality of human resources. In addition, climatic conditions with only 3-4 rainy months per year impact the food products produced by the community. Where there is only enough to meet the needs for 3-4 months per year, the low quality of human resources and the absence of other alternative work causes the fulfilment of food needs to only last up to 8-9 months. People only rely on natural conditions by gathering forest products and hunting. It's just that the techniques used tend to damage the environment. For example, they were hunting by burning fields or making their way into the forest by burning without any conservation efforts. The traditional farming system using slash-and-burn is considered by the community around the Kambaniru watershed an easy, cheap, and fast way to grow. Burning is done when hunting animals and clearing fields. Another reason is to produce a fresh, green pasture that is good for animal feed and allows access to the forest to take tubers, especially gadung (Dioscorea hispida Dennst.) tubers. The poor tend to be unable to take adequate adaptation measures due to lacking human resource capacity and accessibility. So, social protection measures, improvement of human resources, and diversification of livelihoods with pro-poor adaptation are necessary [10-12].

Table 2. Criteria and performance indicators in the Kambaniru watershed

INDICATOR/ PARAMETER	**WEIGHT**				
	%	**%**	**%**	**Skor**	
A. WATER MANAGEMENT	50				0
1. FLOOD AND DROUGHT		30			0
a) River regime coefficient (KRS)			10	3	30
b) Coef of variance (CV)			5	0	0
c) Water use index (IPA)			5	0	0
d) Runoff coefficient (C)			10	3	30
2. SEDIMENTATION		10			0
- Sedimentation rate			10	5	50
3. WATER POLLUTION LEVELS		10			0
- Physics (colour, TDS, turbidity)			4	1	4
- Chemical (pH, DHL, NO3, SO4, PO4, K, Ca, Mg)			4	1	4
- Biology (organic substances, BOD and COD)			2	0	0
Quantity (A)	50	50			118
Water Management Classification Value					**2.36**
Category					**Fair Good**
B. DATA	50				0
1. LAND MANAGEMENT		20			0
a) Land use index (IPL)			4	5	20
b) Land use capability (KPL)			4	5	20
c) Erosion index (IE or CxP)			8	5	40
d) Landslide vulnerability (KTL)			5	3	15
2. SOCIAL AND ECONOMIC		10			0
a) Individual Concern (KI)			3	1	3
b) Community participation (PM)			3	1	3
c) Population pressure (TP)			4	3	12
3. ECONOMY		10			0
a) Dependence on land (LQ)			4	5	20
b) Income level (TD)			2	5	10
c) Land productivity (PL)			2	5	10
d) Environmental services (JL)			2	3	6
4. INSTITUTIONS		10			0
a) Empowerment of local institutions (KLL)			2	5	10
b) Community dependence on the government (KMP)			2	5	10
c) Coordination, Integration, Synchronization, Synergy (KISS)			4	5	20
d) Joint business activities (KUB)			2	5	10
Quantity (B)	50	50			209
Water Management Classification Value					4.18
Category					**Kinda Bad**
Total (A+B)	**100**	**100**		**3.27**	**327**
Watershed Performance Classification Value	**100**	**100**	**100**	**3.27**	**Moderate**

3.3. Erosion prevention through HR development

The role of forest and land rehabilitation (RHL) plants can provide direct benefits to the community by increasing food security and employment opportunities and increasing people's income. The RHL plants are types of plants or trees that can be used as a source of food or livelihood, increasing the population's income in the Kambaniru watershed. Planting RHL crops with community involvement through participation has a double impact. First, it aims to improve watershed performance. Second, to help the community by providing food and increasing employment in the forestry and plantation product industries [6].

Agricultural food crops such as corn in Nusa Tenggara have a high sustainability index considering that economically, ecologically, and socio-culturally it is very feasible to cultivate. The corn cultivation in Nusa Tenggara is possible to develop because it is supported by regional conditions, technology availability, market conditions, and domestic market demand [13]. On the other hand, using land with steep slopes in the form of hilly and mountainous areas for corn plants, from the aspect of environmental sustainability, is very worrying. Therefore, efforts are needed from the local government to deal with dry land with steep slopes. Socialization and dissemination must be encouraged to provide an understanding of environmental sustainability. For example, they were growing food crops in combination with annual harvests of high economic value. For example, annual plants that are suitable for both lowland (Robusta coffee) and highland (Arabica coffee) can be planted parallel to the contour, then combined with stone piles so that, in the long term, they will form a mound terrace, which functions to hold water and soil from erosion [14]. In addition, given alternatives and types of commodities that can be developed, the community chooses the types of annual plants that interest the community. Tree species are easy to maintain and have high economic value to benefit the community. Besides that, food crops can be cultivated without causing land degradation.

Erosion prevention through capacity building of community human resources in the Kambaniru watershed can be encouraged by planting agricultural land and livestock. A community empowerment program is needed, including outreach activities, training, and mentoring. Through community empowerment programs, people can increase their perceptions, preferences, understanding, and skills to support the success of watershed management. Other positive impacts include job creation for the community. Support by the community in determining the type and suitability of plants will increase the success of planting and plant quality. The usefulness of plant species will increase the Land Use Index (IPL), which will encourage an increase in the performance of the Erosion Index.

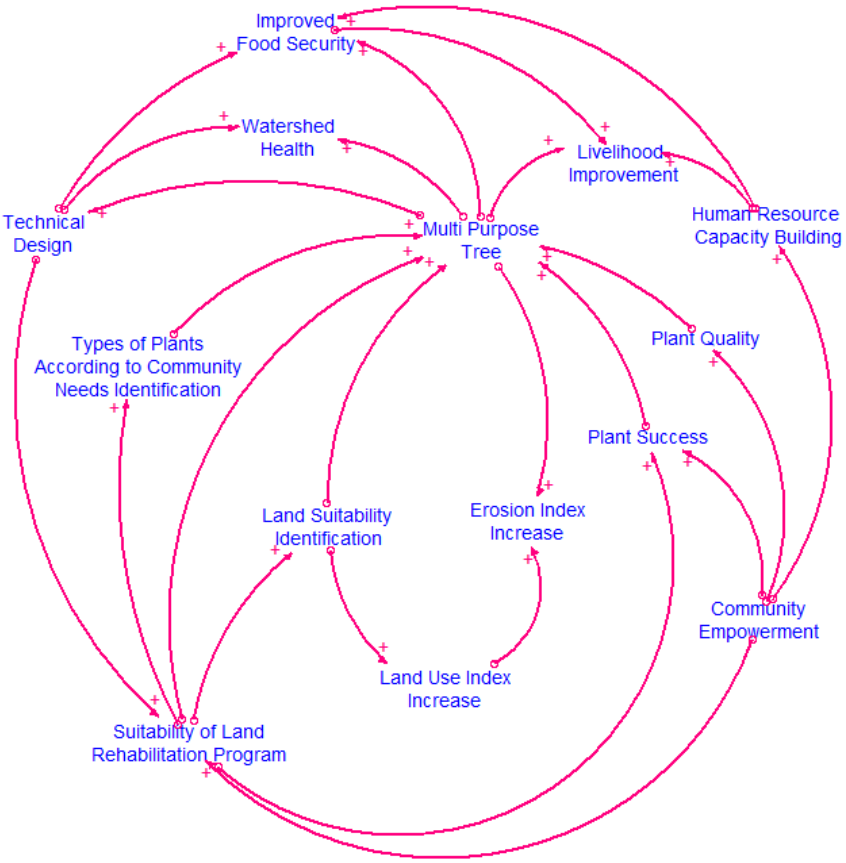

Figure 1. Causal relationship for plant life types and increased erosion index

Based on figure 1, the causal loop shows that the determination of versatile plant species is not only to increase the erosion index and watershed health but also to support the livelihoods of the people in the Kambaniru watershed. In the figure, it can be identified that the direct causes of the decline in health in the Kambaniru watershed are (1) the problem of poverty as the main factor of pressure on land and forests; and (2) agricultural and livestock systems that are less productive and do not pay attention to conservation issues have an impact on low food security and land damage.

The problem of poverty is caused by the accumulation of the issues in natural conditions that limit food production, education level, and employment. Eventually, there will be an emphasis on land and forests to meet their food needs, according to [15]; [11]; [10]. Not only that, the farming and livestock systems practised by the community, especially in the upstream watershed area, can add pressure to the watershed's health, one of which causes environmental degradation such as erosion. Under these conditions, the land can become less productive, which has implications for low food security [10-12]. Therefore, it is necessary to develop indicators of success in preventing land erosion through the development of human resources to support the food security of the community around the Kambaniru watershed. The forms are: (1) increasing employment opportunities, (2) increasing land productivity, (3) increasing food sources (trees and plants), (4) increasing land cover, (5) increasing land use index, (6) reducing erosion, and (7) improvement of watershed performance. This activity can be effective if it is supported by community capacity building, one of which is through community empowerment.

3.4. Land rehabilitation through program strengthening

Based on the socio-economic conditions and the biophysical environment in the Kambaniru watershed area, community empowerment-based forest development requires a method of utilizing space for plants or trees to be developed to improve community welfare and the quality of forest resources. The

commodities that can be produced are multi-purpose tree species. Entities that may be generated can be in the form of wood or non-timber. Some examples of entities are: Group (1) Gum and resin, namely *Gaharu* (Aquilaria Sp), *Nyatoh* (Palaquium spp., Payena spp.), and *Kemenyan* (Styrax benzoin); (2) Fruits, namely *Durian* (Durio spp., especially D. zibethinus), Cashew (Anacardium occidentale), *Kluwek* or *Kepayang* (Pangium edule), Candlenut (Aleurites moluccana), Coffee (Coffea spp.), Pepper (Piper nigrum), Nutmeg (Myristica fragrans), Petai (Parkia speciosa), Breadfruit; (3) other spices, namely cinnamon (Cinnamomum spp.), cloves (Syzygium aromaticum), various gingers (*empon-empon*); (4) The woods are *Jeunjing* (Paraserianthes falcataria), Teak (Tectona grandis), Mahogany (Swietenia macrophylla), Gmelina (Gmelina arborea); (5) Other plants such as Sandalwood (Santalum album), Sago (Metroxylon sago).

The application of agroforestry systems is essential for developing multi-purpose forest crops and characterizing food reserves. It is needed for the needs of human life and for rehabilitating critical land. Furthermore, efforts to rehabilitate necessary land require legal instruments, management and utilization systems, and institutional regulations that support the realization of community participation [16, 17]. Therefore, various multi-stakeholder approaches are needed, both technically, regarding the suitability of land types and types of plants. The agroforestry system provides sustainable benefits, and besides that, it can increase community participation in supporting critical land rehabilitation activities and form solid local institutions [6, 18]. For this reason, the development of agroforestry patterns needs to consider the correct approach pattern, following the capabilities of human resources, the environment, and socio-culture and to select the type of commodity to be developed.

In the upstream and middle areas, people's livelihoods depend on subsistence agriculture, horticulture, grazing or pastoralism, and tourism, while in the downstream, agriculture and fishing are the main livelihood options [6, 10]. By considering various factors of land conditions and the community where most of the population lives in agriculture and animal husbandry, it is possible to develop agroforestry in the Kambaniru watershed, including agro-silviculture, sylva-pasture, and agro-silvopasture. Based on the characteristics of the technology, the suitability of each optimization program and land rehabilitation technique is described in table 3 below.

Table 3. Land rehabilitation techniques to prevent erosion around the Kambaniru watershed

No.	Strengthening Program	Land Rehabilitation System	Land Rehabilitation Techniques	Consideration Professional and Empirical
1.	Community Forest (HKM)	• Agrosilviculture	• Mixed tree species, namely tree of life (food producer), fruit producer (industry), agarwood tree and luxury wood (sandalwood). • Types of food crops are food crops (rice, corn, and tubers). • Intercropping system. • Construction of water reservoirs.	• HKM aims to improve the community's welfare by providing food, employment and income to the population • Limited agricultural land, so dependent on forest land • Food production is sufficient to support 3-4 months • Types of food crops rice, corn and tubers from the forest • Trees of life (such as breadfruit etc.) to increase food reserves • The types of fruits produced are sold to increase farmers' income. • Embung or Retention basin is made for water sources for agricultural cultivation during the dry season.
		• Agrosilvopasture	• In addition to plant species such as those in the agrosilviculture system, fodder crops such as elephant grass (Pennisetum purpureum) and turi (Sesbania grandiflora) are also planted.	• In addition to the agro-silviculture system, it is also for livestock using the cage system
2.	Village Forest (HD)	• Agrosilviculture	• Mixed species of trees of life (food producer), fruit trees producing industrial raw materials (betel nut), agarwood tree, and luxury wood (sandalwood). • Types of crops, namely food crops (rice, corn, and tubers). • Intercropping system. • Construction of water reservoirs.	• The Village Government does not have land for village assets or other limited sources of income. • Planting intercropping crops to meet the food needs of village officials who manage them. • Types of food crops rice, corn, and tubers from the forest. • Trees of life (such as breadfruit) to increase food reserves for the villagers. • Embung holds water for agricultural cultivation in the dry season.
3	Private Forest (HR)	• Agrosilviculture	• Tree species produce wood for the carpentry industry, industry, essential (aetheric) oils, and energy. • Intercropping system with food crops (rice, corn, or tubers).	• HR is aimed at meeting the needs of industrial raw materials, expanding employment and community income. • Demand for wood for industrial raw materials is high. • Land owned for planting community forests is available. • The food crops produced are rice, corn and tubers. • Embungs are used for agricultural cultivation during the dry season
		• Agrosilvopasture	• Tree species produce wood for carpentry and industry, as well as essential oils and energy mixed with leaf-producing plants for animal feed. • Intercropping system with food crops (rice, corn, or tubers) and grasses.	• HR to meet the needs of industrial raw materials, employment and community income. • Demand for wood for industrial raw materials is high. • Land owned for planting community forest is available. • Residents own livestock with a cage system. • Produce food crops, namely rice, corn and tubers. • HR provides animal feed in the form of tree leaves and grass (elephant).

No.	Strengthening Program	Land Rehabilitation System	Land Rehabilitation Techniques	Consideration Professional and Empirical
				• Embungs are used for agriculture during the dry season. • Most of the land cover that characterizes the savanna forest, i.e., shrubs, grasslands, and trees, grows very rarely. • Trees that grow in the ecology of the savanna species are only shrubs and certain grasses, so endemic tree species are prioritized and can increase fertility. • The tree is also used to protect animals and herders
4	Agroforestry and Civil Building Program	• Agrosilvopasture	• Tree species are shade trees that are suitable for living in savanna areas • Communities implement an intercropping system with food crops such as rice, corn, or tubers in the valleys (basins). • Implementation Tree planting starts from valley areas and locations that allow them to grow (near water sources). • Construction of water reservoirs. • It is strengthening the management of grasslands with a system that does not use fire (burning).	• Most people's livelihood is livestock farming with a grazing system. • Tree planting will be successful if it is carried out on soil with relatively deep topsoil and sufficient soil water content so that planting is carried out on a limited basis in that location, which is indicated to be in a valley. • Planting crops for food crops can be done separately from trees, allowing seasonal produce to be grown.. • Water reservoirs are made for water sources for agricultural cultivation and drinking for livestock. • It is necessary to limit the rejuvenation of grass by burning.
		• Civil building construction	• Construction of water reservoirs. • Constructed channels to intercept waterways on the slopes. • Build water flow dams in the valleys.	• Rainfall conditions of less than 1500 mm per year prevent water from being stored in the ground. • Prevent water loss by constructing reservoirs such as water reservoirs, interceptor channels, and dams. • The potential for standing water for a long time is used to plant crops around the location of the puddle.
5	Program of Silvopastoral	• Silvopasture by expanding shade trees	• Tree species are shade trees suitable for living in savanna areas. • Not planting crops because the soil is not suitable for seasonal produce. • Planting of trees is carried out starting from valley areas and locations that allow them to grow (near water sources). • Construction of water reservoirs. • Strengthening of grassland management with a system not using fire (burning).	• Use this system in savanna locations where there are few tree stands or only grassland savanna. • Increase tree planting to curb savanna expansion and desertification.
	Development of Various Forestry Enterprises	• Silvopasture by expanding trees that produce non-timber forest products (*HHBK* /NTFP)	• Communities are utilizing NTFP-producing tree species as community livelihoods, such as calliandra plants and other flowering plants. Other uses are for the honey bee business, planting fruit or tubers for food crops, etc. • Planting trees only take not from the wood, but flowers, fruit, and leaves for other products. • Tree planting begins in valley areas and locations that allow them to grow (near water sources).	• Forest honey from East Nusa Tenggara (NTT) is well-known as a non-timber forest product, so it has the potential to be developed in the Kambaniru watershed. • The NTFP production process does not directly use wood, so the community continues to maintain the presence of the plant or tree. • The required production process is fast. • Commodities produced can increase business and also food security.

No.	Strengthening Program	Land Rehabilitation System	Land Rehabilitation Techniques	Consideration Professional and Empirical
			• Construction of water reservoirs. • NTFP business development outside forest areas.	
6	Environmental Services	• Maintaining the existence of Conservation Forests and Nature Preservation for the use of environmental services such as recreation areas and producing drinking water	• Conduct socialization and increase understanding and perception of the importance of conservation areas and nature conservation for the lives of local communities. • Identify environmental services so that local communities can benefit from conservation forests. • Communities are utilizing environmental services using the principles of sustainability.	• Forest Conservation and Preservation Area is in the Upper Kambaniru Watershed, so apart from its primary function as nature conservation, it also functions as a water catchment area; • In increasing the existence of Conservation Forests and Nature Preservation Forests, it is necessary to increase the development of Environmental Services for residents around the forests; • Development of environmental services business, which includes the development of recreation areas and drinking water businesses.
7	Environmental Greening	• Agrosilvopasture	• In private lands around settlements, it is necessary to plant reforestation to support the environment as well as the population's livestock business. • Types of trees planted are trees that can be used as forage for livestock and fruit crops.	• The use of this system in residential areas can support environmental improvement and, at the same time, support livestock or fruit crops. • Increase the availability of forage trees to support animal feed and increase fruit trees on land around settlements (gardens, fields).

4. Conclusion

The slash-and-burn habit or culture of cultivating land by the community is difficult to eliminate. Therefore, a program to increase the cropping index is needed so that it can improve land quality and productivity. Cultivation technology innovations and supplementary water resources (dams, reservoirs, and others) are the main leverage points in increasing the cropping index, production, and plant productivity. The type of technology needed by the community is not only easy and cheap but also efficient in supporting food crop farming and local government food security programs.

The policy implication of this research is that the limited capacity of human resources results in not caring about land conservation. Therefore, it is necessary to socialize the planting of short-lived trees for land conservation, for example, species of the legume family. This plant can thrive in various soil types and is flexible with climate changes. Corn and tubers are a source of high calories and nutrients needed to improve the quality of human resources in the Kambaniru watershed area. Therefore, developing a food reserve land program in the Kambaniru watershed is necessary.

Acknowledgments

The author would like to thank you LPPM Sahid University Jakarta for supporting this research.

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