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RESEARCH ARTICLE

EMPOWERMENT OF AGROFORESTRY FARMERS IN SUSTAINABLE FOREST AREAS IN PUJON SUB-DISTRICT MALANG DISTRICT.

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Abstract

The agroforestry system is in response to the concerns that arise as a result of the increase in population with reduced area or land in an effort to anticipate a reduction in food sources. The purpose of knowing the pattern of agroforestry farmers' development towards farming is from an ecological management aspect that is able to support the realization of sustainable production forest resources.
Taking method using Slovin model and approach using Participatory Rural Appraisal / PRA. Data analysis using the Structural Equation Model (SEM) model with the help of the WarpPLS program (development of Partial Least Square). Based on the analysis of agroforestry farming that shows that the process of agroforestry farmer empowerment has a significant effect on community empowerment. The results of this empowerment process are marked as follows: politics with agroforestry farmer performance has path coefficient -0.07 with P-value 0.01; economy with performance has a path -0.268 and P-Value <0.001; social culture with performance has a path of 0.073 and P-Value 0.019; management with performance has a path of 0.061 and P-Value 0.043; ecology with performance has a path -0,093 and P-Value 0,004; empowerment with management has a path -0.048 and P-Value 0.089; and management with ecology has a path of 0.049 and P-Value 0.082; support in facilitating the success of empowerment, so that it can increase the independence of sustainable agroforestry farmers. The majority of agroforestry farmers agree that the management of forest areas with an economic variable of 61% is in the high category of environmental management with an answer level of 3.68, the overall management capacity variable of 4.76 in the high category of empowerment is also perceived to be high.
Agroforestry with a dairy cow-based silvopasture system to provide benefits to farmers averaging Rp. 22,250,000. - / year, B / C Ratio (2.33) Based on the results of the analysis, the size of the share of land, the number of livestock and the level of development of agroforestry in an ecological and economic manner have a significant effect on sustainable farmers.

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Introduction:-

Background:-

Ecologically, agroforestry systems in some cases have succeeded in creating an environment that is not monoculture, so that the ecological balance is more secure and able to increase crop production (Alavalapati and Nair 2001; Van Noordwijk, 2004). Socio-economically, agroforestry can increase the income and welfare of the community around the forest because short-term needs can be met from agricultural crops and non-timber forest products (NTFPs). Timber forest products and NTFPs from an agroforestry activity will also provide economic benefits in the long periods (Michon et al. 1986; Campos et al., 2010). The success of agroforestry in realizing sustainable forest management can at least be a solution to several issues that concern the community globally such as poverty, food security and global warming (Zijderveld et al., 2010). However in realizing the success of agroforestry there are several challenges, namely government policies, the capacity of communities around the forest, business capital and product marketing. Government policy plays an important role especially in regulating people's access to forest resources, providing increased capacity and technology in the development of agroforestry (Montpellier, 2013)

The government through BUMN which named *Perum Perhutani*, implements Collaborative Forest Management (CBFM) which is structured as a win-win solution strategy and accommodates agroforestry (Adiputranto, 1995). Actually in the field, agroforestry patterns that exist in CBFM do not only occur through intercropping activities for making forest plants (Suharjito, 2014). But the community also planted shade-resistant species that could increase their income from agriculture and livestock.

The pattern of utilization in CBFM areas for agroforestry activities is closely related to the level of development of existing agroforestry and the social character of the community. In agroforestry with the initial level of development, namely in young plants, the allocation of plant space is still high compared to agroforestry with mid-level and advanced development (Sileshi et al, 2007). Crop productivity increase will have an impact on people's economic income directly. The pattern of agroforestry utilization can be understood based on the form of land use, cultivation techniques used and products produced from agroforestry activities (Iriany et al. 2013), while the contribution of economic income utilization patterns can be done through analysis finance (Sendzimir et al., 2011).

Research purposes:-

The purpose of this study is to: analyze forest land use as an effort to empower agroforestry farmers in increasing sustainable income and analyze operational management characteristics of the environment, empowerment and sustainability of farming in the ecological management aspects of sustainable agroforestry.

Research Methods:-

Time and Location of Research:-

The place of research was carried out in villages at Pujon sub-district, the administrative administration of this village was located in Pujon Sub-district, Malang Regency, which carried out from June to October 2018.

Research object and instrument:-

Objects in agroforestry farmers' research at three levels of development of agroforestry are; at the initial, mid and advanced levels. The equipment used in this study included: stationery, calculators, questionnaires, cameras, recording devices, tree height gauges, phi-bands, meters, roll meters, mines, tally sheets and computers.

Types and data sources:-

The data used in this study categorized primary data obtained by conducting direct observations in the field (vegetation data and socio-economic data) of agroforestry farmers, and secondary obtained from relevant agencies, literature or other publications.

Sampling method:-

In this study, the sampling method used was participatory stratified purposive random sampling which is a modification of Participatory Rural Appraisal / PRA (Chambers, 1996). The sampling step begins by making the strata of forest area plots based on the level of agroforestry development. In making the classification of variables that form the basis of classification is the age of the main forest plantations. The principal plants are less than 2

years old with more than 50% of the field of agricultural crops classified as initial agroforestry. The 5-10 year old with an agricultural field of 25-50% are classified as mid-agroforestry, while more than 10 years old plants with an agricultural field of less than 25% are categorized as advanced agroforestry. After the plot is determined, in each plot then the number of farmers (respondents) is determined purposively according to the research needs. The number of farmers at each level of development of agroforestry is calculated by the Slovin formula in Husin (2004);

$$n = \frac{N}{1 + Ne^2}$$

Where:
n = Number of samples
N = Number of population (Head of Family) who owns agroforestry land
e = Error sample that is still allowed (0,1)

For 20 x 20 m measuring plots for observation of trees in > 20 cm diameter; 10 x 10 m measuring plots for measuring trees in 10–20 cm diameter; 5 x 5 m measuring plots for measuring sapling or shrubs planted by farmers, while 2 x 2 m plots for observation, agricultural crops, grass and other plants..

Data analysis method:-

a. Analysis of the Spatial Pattern of Agricultural Crops

Space utilization is done vertically by calculating the percentage of canopy cover of perennials and agricultural crops. According to Doubenmire (1959), the percentage of canopy is calculated by dividing the number of canopy areas of all trees in a plot with a plot area. The formula for calculating canopy percentages is as follows:

$$T = \frac{\sum AT}{AP} x100\%$$

Where:
T = Percentage of canopy cover of forestry perennials (%)
AT = canopy area of each tree in a plot (ha)
AP = Area of plot ($25m^2$,$100m^2$ or $400m^2$), while for the closure of agricultural plants, especially in under-plants. The following formula is as follow:

$$Tp = \frac{AT}{AP} x100\%$$

T p = percentage of lower vegetation (%)
AT = area of agricultural crop cover (m2)
AP = plot area (2 x 2 m)

If the extent of agricultural canopy is difficult to measure, then observations are made by estimating directly the percentage of crop cover compared to the plot area. By using a vertical space approach, the field of agricultural crops is formulated as follows: RP = 100% - T

Where:
RP = space for utilization of agricultural crops (%)
T = percentage of utilization space for forestry perennials

b. Analysis of the Business Benefits of Agroforestry

According to Soekartawi (1995) the benefits of agroforestry business are the difference between the amount of revenue and the amount of costs incurred in the agroforestry process, so the formula used is:
Where:
π = Total profit or profit
TR = Total revenue or revenue
TC = Total cost or cost

Revenue is a multiplication between productions obtained from a farming activity with a selling price (price), so the formula used is: $\pi = TR - TC$

Where:
TR = Total revenue
Y = Production obtained in farming
Py = Price Y

Analysis of the B / C ratio as a comparison between the total revenue (TR) and the total total production cost (TC) formulated as $\mathbf{B/C} = \frac{\mathbf{TR}}{\mathbf{TC}}$

Where:
TR = Total revenue
TC = Total Cost

If the value of the B/C ratio is > 1, it means the farmer's agroforestry business is profitable. If B/C ratio = 1, it means that the farmer's agroforestry business breaks even if the B/C ratio <1 means that agroforestry farming is not profitable.

c. Structural Analysis of Equation Models (SEM)
Analysis is assisted by the WarpPLS program (development of Partial Least Square) which is able to accommodate indicators that are reflective and formative.

Research Result And Discussion:-

Determination of Land Area:-

a. Extensive estimation of Cover:-
The forest area used as an example in this study is plot 93C, 94C and 94G. The basis for the selection of the three subplots is because the age and quality of stands is considered to represent the level of agroforestry. In the 93C plots with the 2011 planting year the plants may have a canopy closure of staple plants below 50%, thus allowing intercropping of annual crops. In plot 94C, including KU II, potential plants have canopy cover between 50-75% (effective field of agricultural crops between 25-50%) which allows *silvopasture* activity. In plot 94G it is estimated that canopy cover reaches more than 75% (effective field of agricultural crops <25%) and allows *silvopasture* activity (Table 1).

Table 1:-Characteristics of subplot research

Sub-plot	Width (Ha)	Planting Year	Staple Plants type	Plants age (Year)	Age classsification	Canopy Cover estimation (%)	Estimation of Agricultural Crops Field (%)	Estimated Level of Development of Agroforestry
93C	7,5	2011	*Eucalyptus sp*	1	KUI	< 50	> 50	Beginer
94C	24,1	2006	*Eucalyptus sp*	6	KUII	50 – 75	25 – 50	mid
94G	6,4	1999	*Pinus merkusii* Jungh.& De Vr	13	KUIII	>75	< 25	advance

Source: Register the Minutes of South Pujon RPH Forest in 2011

b. Basic Plant Conditions
Based on the results of the analysis of vegetation measurement data, the condition of growth of staple plants grows relatively well. The dimensions of staple plants, especially plant height, number of trees per hectare and canopy radius causes the percentage of canopy cover to be greater with increasing age of plants. Plot 93C which is the initial level of agroforestry has an average percentage of cover 60% and effective field crops agriculture by 70%. In plot 94C, which is the level of mid-agroforestry, it has an average percentage of canopy cover of 80% with effective plant space of 75%. Whereas in the advanced level agroforestry canopy cover reaches 60% and the potential field of agricultural crops is 60% (Table 2).

In the initial level of agroforestry farmers plant crops and vegetables. This is because the effective field is relatively high. Based on the results of measurements on the plot in the field the average percentage of agricultural crops reaches 75%. At the level of agroforestry the types of plants planted by farmers are generally divided into 4 planting seasons, the first planting season (MT1) started in October to December, MT2 starting in January to March, MT3 starts April-June and MT4 July-September. The selection of plants every planting season, farmers have several considerations including the availability of water, plant adaptation to weather or climate, intensity of pest and disease attacks and selling prices of plants. There are many stratified agroforestry systems, when mature trees remain owned by farmers and remain integrated with various other beneficial plants "(de Foresta et al, 2000; Delgado et al, 2012). This dependence is based on the use of improved soil fertility immediately after forest clearance and increased light availability for plants after tree thinning "(Penman et al. 2003). Modifications in microclimate conditions are generally produced by agroforestry (light radiation, temperature and drought) means integrated systems are more suitable (Papanastasis et al 2009).

Table 2:-Condition of staple crops and crop cover at the level of development of agroforestry

Vegetation Parameters	Level of Agroforestry Development		
	Early Agroforestry	Mid Agroforestry	Advanced Agroforestry
	(93C)	(94C)	(94G)
Types of staple Plants	*Eucalyptus sp*	*Eucalyptus sp*	*P. merksuii*
Average diameter of staple plant (m)	0,165521	0,178254	0,206901
Average height of staple plant (m)	19	18	19
Average number of trees per hectare of staple plants (trees / ha)	140	120	96
Average canopy radius of the staple plant (m)	1,5	2,5	3
Average percentage of staple canopy cover (%)	60	80	60
Average field of effective farming (%)	80	75	60
Average estimates of agricultural or grass crop cover (%)	30	25	40

Source: primary data processing of 2018

Equitable and complementary land use, with the aim of producing various goods and services for individuals and society in general "(Sardjono, 1990; Hairiah, et al., 2003; Hani et al, 2016). In MT1 most farmers grow broccoli and cabbage = 18%. MT2 and MT3 types of plants are relatively varied, while in MT4, corn and potato are dominated by a percentage of more than 15%.

c. Productivity of Agricultural and Grass Plants

The productivity of agricultural crops on agroforestry land at the initial development level is determined by the type of crop, the mid and advanced levels are determined by the percentage of canopy cover of the main plant. in advanced agroforestry at 40% of the area. Based on the results of interviews with respondents, it was explained that in order to get one bunch of grass, a minimum area of grass was needed as large as 4 m2 (0,0004 Ha) and harvesting rotation took about three months.

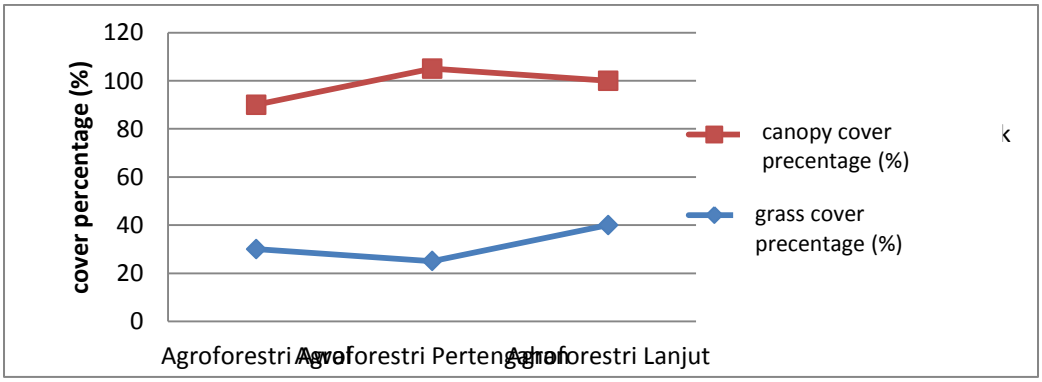

Figure 1:-Diagram of the percentage of canopy cover of staple plants and Grass cover in mid and advanced agroforestry fields.

At the level of intermediate and advanced agroforestry the types of plants under the stands are types of (*Pennisetum purpureum*) which are planted as a source of forage for animals (HMT) for dairy farming business. Ecological interaction between trees and other components is well above the ground (such as shade, evapotranspiration) or below the surface (Evan, 1992). In mid-level agroforestry produce grass = 7 bunches / day and in advanced agroforestry = 5 bunches/day. Rotation of harvesting grass at both levels of agroforestry is very dependent on weather or climate, during the rainy season the harvest rotation is for 3 months, while in the dry season the harvesting takes longer between 4-6 months

Agroforestry practices to improve food security, income, and livelihood opportunities for rural communities and protect the environment, through accelerated adoption of fertilizer trees, fruit trees, fodder trees and wood fuel trees (Mosquera, 2010 and 2012). Forest land has been able to become a source of forage for dairy farms in the Pujon District area

Business Income Agroforestry:-

a. Business Income of *Silvopasture* Based Agroforestry

The results of the analysis of agroforestry business income model of dairy cattle *Silvopasture* provide an average profit of Rp. 17,725,000/year. with a B/C ratio of 2.33. Economically, this business provides welfare for farmers. The value of income that will be received by farmers will be higher than that value if the costs are calculated, namely the workforce of IDR 2,500,000/year. The level of development of agroforestry also affects farmers' income. Advantages of agroforestry covering 0.125 ha=Rp.11.375.000,- /year, agroforestry covering 0.5 ha= Rp. 21,250,000/year is presented in Tables 3 and 4. Differences occur because the number of livestock in the owner of 0.5 ha of land is greater than the number of livestock owned by the land of 0.125 Ha. Grass production at the level of agroforestry experienced a difference, because on land 0.25 Ha was included in mid-level agroforestry with a lot of grass production, while for 0.5 Ha it was included in advanced agroforestry with grass production decreasing due to the influence of tree canopy closure .

Table 3:-Number of dairy cows on various agroforestry land areas

Number of Respondent Dairy Cows Ownership	Land Area of Agroforestry						Total	
	Widht of 0,125 Ha		Widht of 0,25 Ha		Widht of 0,5 Ha			
	Amount	%	Amount	%	Amount	%	Amount	%
< 3	18	2,25	60	7,52	152	19,07	230	28,85
3-5	134	16,81	178	22,33	208	26,09	520	65,24
>5	0	0	9	1,12	38	4,76	47	5,89
Amount	152	19,07	247	30,99	398	49,93	797	100

Source: Primary data processed in 2018

Table 4:-Recapitulation of *silvopasture* based agroforestry income analysis

Item Analysis	Land area of Agroforestry			Rerata
	0,125 Ha	0,25 Ha	0,5 Ha	
Average grass production (bunch / day)	6 bunches	7 bunches	5 bunches	6 bunches
Average number of cows (head)	2	4	4	3
Average milk production (liters / day / head)	25	30	30	28
Receipt of tillers (IDR / year / head)	5.000.000	5.000.000	5.000.000	5.000.000
Receiving milk (IDR / year)	11.250.000	27.000.000	27.000.000	21.750.000
Production facilities and	3.375.000	6.750.000	6.750.000	6.525.000

infrastructure costs (IDR / Year)				
Labor costs (IDR / Year)	1.500.000	3.000.000	3.000.000	2.500.000
Total cost (IDR / Year)	4.875.000	9.750.000	9.750.000	9.025.000
Profit (IDR / Year)	11.375.000	22.250.000	21.250.000	17.725.000
B / C Ratio Average	2,33	2,28	2,28	2,29
Animal feed costs *)	10.000/ bunch	10.000/ bunch	10.000/ bunch	10.000/bunch

Source: Primary data processing (2018)
*) Animal feed costs if calculated

Cost effectiveness analysis must consider not only local scale but also role system management as part of a broader scale landscape strategy "(Cote et al. 2010; Fadlina et al, 2013). Development of forest areas in the tropics is developing forest management systems and agriculture that allows the use of natural forests while preserving their resources (Costanza, 2000; Fagerholm et al 2016 and Fanani, 2017).

Ecologically, the *agrosilvopasture* business will also have a more positive impact compared to the cultivation of vegetable crops. This happens because the planting of forestry combined with grass plants will make the soil more closed, thereby reducing erosion, while planting agricultural crops with vegetables requiring more intensive tillage causes the soil to be relatively easier to experience erosion (Mayrowani and Ashari, 2011). Agroforestry system was creating an ecosystem where biodiversity depends on initial soil conditions (Mosquera et al., 2009a, b), tree species (broad-leaved conifers) and planting densities (Affandi, 2002; Rigueiro-Rodríguez et al. 2010a).

Several factors that influence the farmers' income level are; factors in the area of land, number of livestock and the level of development of agroforestry. In accordance with several researchers, the potential of agroforestry systems to provide economic, environmental and social benefits in Europe European Union research "(McAdam et al., 1999a, b., Sibbald et al. 2001., Burgess et al. 2003, 2005., Mosquera et al. 2010 & Dupraz et al. 2005). Therefore, through an approach science and technology farmers should be able to obtain optimum benefits from farming land use at various levels of development of agroforestry without having to damage forestry. Agroforestry systems are related to social, economic and environmental conditions, but are more specialized on the profit side (Michon et al, 1986) Furthermore, Campos et al. (2010) stated that "profitability depends on the output that agroforestry systems provide and have the value given by the community to all their farming products within a certain period of time. Income depends on natural conditions for farming, the more supportive natural conditions, the higher the chance to get good results, and vice versa (Muflikhati, et al., 2010; Martawijaya, 2010).

b. Empowerment of Agroforestry Farmers

The results of Structural Model (SEM) analysis with the help of the WarpPLS program (development of Partial Least Square) are able to accommodate indicators that are reflective and formative. Empowerment is measured by eight reflective indicators. The results of outer loading indicators from empowerment show a high value between 3.68 - 3.70 the suitability of empowerment and dissemination of counseling about the environment.

All business sustainability indicators have an average value in the high category between 3.18-4.68 except for the second indicator, namely the activities of the community / farmers planting trees to improve the quality of the environment with an average value of 3.18. The smallest average value above is an indicator of an increase in tree planting activities of 3.18, because on cultivated land farmers are still in a tight stand condition, so there is no need for tree planting activities. From the average value of overall business continuity from the aspect of ecological management of 4.07 in the high category, it can be said that the business continuity from the ecological aspect is perceived by the respondents to be high. The frequency distribution of the response to each question item is summarized in Table 5.

Table 5:-Ecological Variables

Indicators	Frequency of Answer Options in%				Average Answer
	1	2	4	5	
The importance of the forests existence	0	0	31	69	4,69
Tree planting activities	0	41	59	0	3,18
Forest maintenance and supervision	0	0	44	56	4,56
Limiting land conversion activities	0	0	35	65	4,65

Operating revenues	0	31	69	0	3,38
Addition to business assets	0	0	32	68	4,68
Additional area	0	0	45	55	3,55
Customer compliance with regulations	0	3	97	0	3,94
Variable Average					4,07

Source: Primary data processed in 2018

Sustainable agroforestry business performance is measured by five indicators, there are; agroforestry crop production, net income from crop yields, addition of production facility assets, addition of land area, sustainability compliance through the introduction of agroforestry (Makundi et al, 2004 and Maroyi, 2009). The smallest average value is an indicator of the addition of land area which is 3.80. Ecology will have a direct impact on performance, namely increasing ecology will significantly reduce performance (Suryanto, et al. 2005). While the highest average score of 4.39 on the indicator of increasing customer compliance with government regulations, the answers of respondents 61% said they agreed and strongly agreed, 39% of government regulations related to environmental sustainability. The frequency distribution of responses to each question item is summarized in Table 6.

Table 6:-Performance Variables

Indicators	Frequency of Answer Options in%				Answer mean
	1	2	4	5	
Average of agroforestry production per planting season	0	0	100	0	4
Average of farmer's net income	0	0	100	0	4
Addition to assets of production facilities	0	0	83	17	4,17
Additional land area	7	0	85	8	3,80
Sustainability compliance through the introduction of agroforestry	0	0	61	39	4,39
Variable Average					4,07

Source: Primary data processed in 2018

From the average value of overall sustainable agroforestry farming business performance of 4.07, it can be said that the performance of sustainable agroforestry farming is perceived by respondents to be high. Hasibuan (2001) suggests performance (work performance) is a result of work achieved by someone in carrying out tasks assigned to him based on motivation, ability, experience skills and time and opportunity. Agroforestry systems are generally more productive than treeless land use systems "(Dupraz et al. 2005 and Rigueiro et al. 2009). Agriculture integration systems promise for sustainable agricultural intensification (Godfray et al, 2010 and Gil et al, 2015). Zijderveld explained that "intensive production systems can accelerate system adoption and environmental sustainability for the future (Zijderveld et al, 2010).

Conclusions And Suggestions:-

Conclusions:-

Based on the results of field observations and analysis of research data, it can be concluded as follows:

1. In the initial agroforestry farm, farmers are more likely to plant vegetables and secondary crops with crop rotation divided into 4 planting cycles. All majority was strongly agree with the pattern of agroforestry development as evidenced by the opinions of respondents who agree on the pattern of agroforestry development as much as 20% and strongly agree as much as 80%. Economic agroforestry continues to be practiced by farmers to obtain economic benefits from land that is said to be relatively unproductive and is mostly limited to silvopastoral practices.
2. The silvopasture model of agroforestry in dairy cattle provides an average profit of Rp. 17,725,000 / year. with a B / C ratio of 2.33. The value of income that will be received by farmers will be higher than that value if the costs are calculated, namely the workforce of IDR 2,500,000 / year. An area of 0.125 ha of agroforestry has a profit of Rp. 11,375,000 / year, while an area of 0.5 ha in agroforestry is Rp. 21,250,000, - / year. Farming is also a significant source of strategic cash in critical times contributing to farmers' household income in overcoming poverty and increasing household food security.

Suggestion:-

It is hoped that through this research, farmers can increase land intensification by taking into account the developmental level of agroforestry in order to provide a positive ecological impact in the form of a more balanced environmental sustainability by reducing the level of forest destruction and improving the community economy with optimum agroforestry development patterns.

Policy of support, greater awareness and understanding of the benefits of integration and efficiency of agroforestry systems, institutional commitment, and increased use of resources for future integrated systems.

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