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MODEL OF TREE SHADE VALUE BY CONTINGENT VALUATION TECHNIQUE ON THE COCOA AGROFORESTRY OF CENTRAL SULAWESI PROVINCE

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ABSTRACT

Agroforestry is a technology of avoiding deforestation and forest degradation and to increase cocoa production. Consider these, UNREDD recommends it as an activity of REDD+ implementation. This study aims to construct a model of the shade economic value in cocoa agroforestry. Contingent valuation survey was pursued on 211 respondents in five villages. We used the Two Stage Random Sampling Method to have both villages'sample and respondents'sample. Multivariate analysis involved one dependent variable (value of tree shade; Y) and eight independent variables. PCA was used to solve multi-colinearity. The scree plot obtained shows two factors with eigenvalue > 1. OLS Linear Regression developed a model Y= 35.05 + 3.11 Fee + 7.0 Fse + ε with R^2 = 91.9% where Fee = f(X1; X2;X8) and Fse = f(X3; X4; X5; X6; X7). Mean of the shade economic value is IDR 35,000.00 per month per one percent of additional shade in one hectare. The model explains that 35.05 is value, predicting Y if Fee (ecology-economic) = 0 and Fse (socio-economic) = 0. Parameter 3.11 represents the difference in the predicted value of Y for each one-unit difference in Fee, if Fse remains constant. Parameter 7.0 is interpreted as the difference in the predicted value in Y for each one-unit difference in Fse, if Fee remains constant. The mean of tree shade allowed by respondents is 31.67%, while the minimum and maximum shade allowed are 19% and 42%. Mean of actual tree shade practiced by the farmers is 18%.

Keywords: Central Sulawesi, Cocoa Agroforestry, Economic value, Model, REDD+, Tree shade.

Contribution/ Originality

This study is one of very few studies which have investigated on the economic value of tree's shade in Agroforestry for REDD+ policy implementation, and it contributes in the existing literatures about the shading in Agroforestry systems.

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1. INTRODUCTION

Cacao *(Theobroma cacao* L*)* is the main cash crop of Indonesia archipelago, especially in Sulawesi Island. The plant produces cacao beans that are exported primarily to Europe and North America to be row materials for producing cocoa and chocolate. Together cacao and coffee are the largest legal international trade volume beside petroleum, which are the crops most commonly grown under shade trees to avoid physiological stress impacting sustainability of the production [1, 2]. As a big producer, Indonesia yields cocoa beans for either consumed domestically or exported. Indonesia has a comparative advantage on producing cocoa beans, but the other producing countries [3]. Ivory Coast and Gana, has also comparative advantage in producing cocoa beans and their RCA (revealed competitive advantage) index are several times higher than Indonesia.

Growing cacaos under trees is an agroforestry technique that has been an interesting object of researches and publications. The researchers and authors cite the benefits of the trees such as shade to cocoa, soil fertility maintenance, biodiversity conservation, protection against drought, bush fires and insect attacks and additional income through sales of timber species, fuel wood, and non-wood forest products [4, 5]. Further explanation that although some areas in Africa (e.g Cameroon and Ghana) and Latin America (e.g. Brazil, Mexico) still grow cacao traditionally under permanent shade, and shade reduction that is in ongoing farming process in many parts of the tropics particularly in Southeast Asia including in Central Sulawesi, Indonesia.

Increasing the shade will make an implication in cacao Agroforestry systems. It can mean to decrease cocoa production than will affect income lost to the farmers. This is also in control with what the farmers have been doing in establishing their cacao plantation. They have introduced the crop by forming a forest garden and shift to large-scale forest encroachment and forest thinning. Shade removal is still a practical technique to decrease pest and disease pressure. Not only technical raison behind the shade removal, but a number of socio-economic factors makes the farmers do it, especially as an evidence of an investment. Despite all those arguments of hindering to increase tree shade in the agroforestry, recognizing the role of the forest and agroforestry biomass on mitigating climate change and global warming is a strategy background to increase the shade as an effort to increase agroforestry biomass. Mature agroforestry should contain in average 70 to 100 t C per hectare [6]. It is a promising stock's performance comparison with allowing a forest fallow to regrow and accumulate 35 to 50 t C ha^{-1} over the first 40 year period. Agroforestry systems show a significant carbon accumulation and demonstrate the potential of carbon sequestration. Furthermore, Agroforestry system can contribute to reduce CO_2 emission by avoiding the burning of forests.

The potential of agroforestry to conserve and stock carbon makes this land use systems as the REDD+ activities in Central Sulawesi Province recommended by UNREDD [7]. Agroforestry is not only reducing forest encroachment but also can be an option to increase the density of trees on non-forest land. By combining trees and crops in agricultural land, Agroforestry can store and sequester more carbon than conventional agriculture. Furthermore, Agroforestry can often be more accessible to local community than intensive monoculture production systems due to its lower initial investment need. This article aims to develop a model of economic value of tree shade in cocoa agroforestry by using Contingent Valuation approach. The research was an effort to fill an empty space in the REDD+ policy in order to compact the policy. This will also be a wise attempt to rationalize a decision process making by the farmers in managing their agroforestries. The role of agroforestry practices in climate change and global warming mitigation in the province can be realized to its full potential by overcoming various barriers.

2. RESEARCH DESIGN AND METHODS

2.1. Theorical Framework: Economic Values Under REDD+ Scenario

The objective of the tree shade valuation in agroforestry system is to integrate the economic value of the trees services in the plot scale and global scale into the conventional economic decision process pursued by decision makers. Economic value is the prices paid in market and the consumer surplus obtained by the users [8, 9]. There were more than thirty studies on forest valuation of the contingent valuation in the world, and it was concluded that it is important to aware of citizens' preference when designing forest programs in order to increase their acceptability [10]. An interesting argument of estimating forest values is not only as a key role in formulation of a successful forest policy, but also as determination of the real contributions of forest resources to sustainable development [11].

Shaded area below P curve and above $S+S_{\text{under REDD+ Shenarios}}$ curves in the Figure 1 is the object of the valuation of this research. P curve depicts cocoa production of cocoa agroforestry, and S depicts shade of the agroforestry trees. In point a, there are two choices to do, increasing and decreasing the shade.

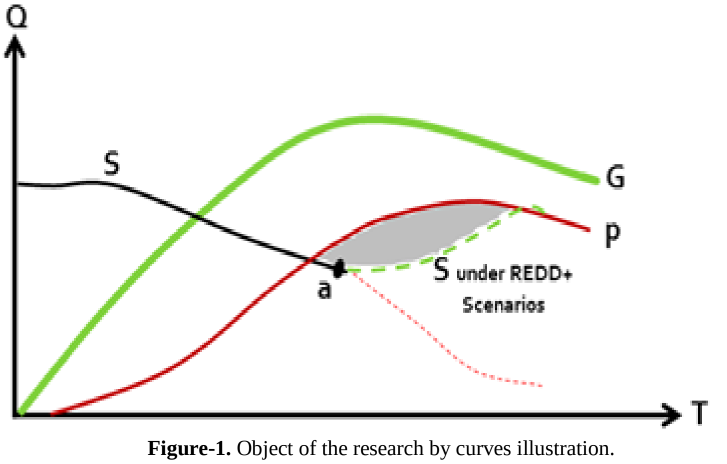

Figure-1. Object of the research by curves illustration.

Since cocoa yield decrease non-linearly with increasing shade, farmers need to remove a part of shading tree in order to keep the increment of cocoa production. Removing the shade will affect carbon emission due to biomass lost from the cocoa agroforestry. Emission from agricultural activities coverts 14% of 3.5 x 10^9 ton C emitted to the atmosphere a year [12, 13]. It is important to know that it is possible to design cocoa-based agroforestry with good yield (cocoa and shade canopy) and high carbon stock level [14].

The research estimated tree shade value of cocoa Agroforestry by directly asking Agroforestry owners to state their preferences about the tradeoff between lost and gain based under the REDD+ scenario of the contingent valuation (CV). We assumed that the CV survey presented the households with the prospect of securing a change in provision of the tree shades in the Agroforestry from its present level (Q^0) to a greater level (Q^1). Also, we assumed that the survey was worded so as to elicit a household's minimum WTA *(willingness to accept)* to achieve the change. We constructed an idea that WTA is an expression of household's utility (U) where this will describe the maximum amount of utility a household can derive from their lost (L), given the price of cocoa (P), and the level of provision of the tree shade (Q). It is also assumed that the household's utility depends on other demographic and economic factors (S).

The respondents answered the CV question by comparing their utility at two levels of provision, Q^0 and Q^1. Since they have experienced greater welfare at the lower level of provision, it is reasonable to assume that the respondents would propose their willingness to accept as compensation they have due to lost they have at maximum level Q^1 allowed. Indeed the respondent's minimum WTA can be formally described as the monetary value they earn to ensure that their welfare with the higher level of provision is just identical to their welfare at the lower level of provision. We have defined a quantity C such that:

$$U(L+C , P , S , Q^0) = U(L , P , S , Q^1). \quad (1)$$

C is the compensating variation measure of a change in welfare in the form of the household's minimum WTA to achieve the increase in the provision of the tree shade of cocoa Agroforestry. After having manipulated the recent equation, C was defined as a function of other parameters in the model. This function, which we denote C (.), can be written in general form as:

$$C=C(Q^0 , Q^1 , L , P , S) \quad (2)$$

The equations 1 and 2 provided the basic theoretical framework for the analysis of the research data. WTA data were bounded by willingness to accept of the respondents that must be greater than their lost, or in mathematical notation:

$$C(Q^0 , Q^1 , L , P , S) = WTA \geq L \quad (3)$$

We recognized that the relevant measure of income in this case was discretionary lost. It is about production lost due to tree shade application.

2.2. Data Gathering and Methods of Analysis

The elicitation of the individual's preference on the tree shade of REDD+ scenarios was done through the CV survey of 211 respondents of five village samples (Bunga, Bobo, Kapiroe, Rahmat, and Berdikari) in the Palolo sub District, Sigi district of Central Sulawesi Province, Indonesia. We used Two Stage Random Sampling Method to have both villages' and respondents' samples. WTA refers to minimum amount of money an individual would asked to cede a good, or give up the right to use it Riera, et al. [15]. WTA denotes as Y of dependent variable and independent variables are the results of transformation of equation 3 and we have X1 (estimated lost due to tree shade), X2 (land owned), X3 (number of household members), X4(respondent age), X5(gardening experience), X6(perception on agroforestry), X7(perception on the shade), and X8(maximum shade allowed). We used open-ended format of CV format by letting the respondents determined their WTA freely through face-to-face interviews survey mode.

The analysis used multivariate analysis by combining factor analysis based principle component analysis (PCA) with ordinary least square regression (OLSR). Principle Component Analysis (PCA) is a traditional multivariate statistical method commonly used to reduce the number of predictive variables and solve the multi-colinearity problem [16]. The whole stages of data analysis are shown by the scheme (Figure 2).

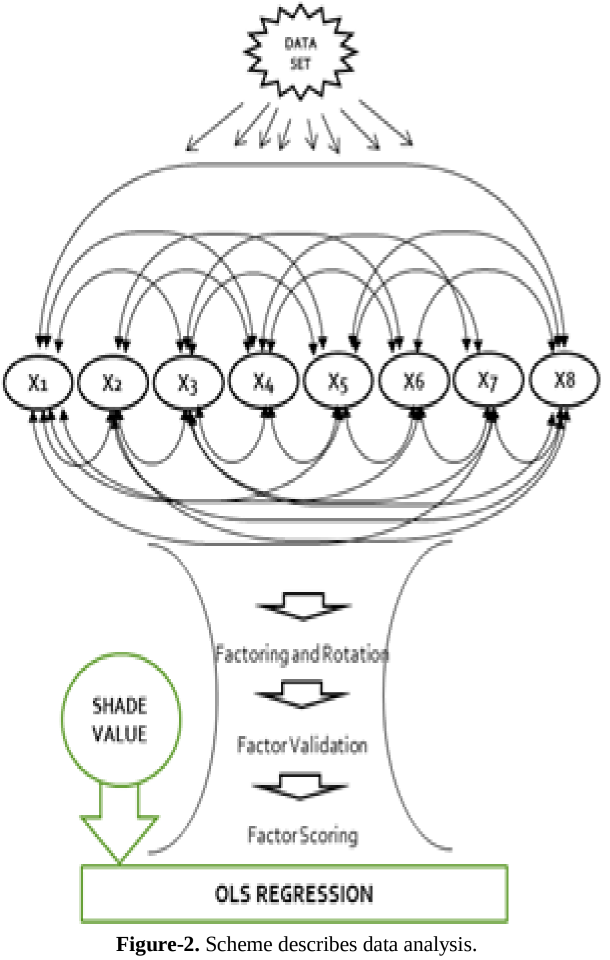

Figure-2. Scheme describes data analysis.

The starting point of the analysis was pursuing descriptive statistics and the starting point of PCA was preparing the correlation matrix. The purpose of descriptive statistics is to describe the basic feature of the data. Meanwhile correlation is important since PCA is mainly concerned with identifying correlation in the data. The whole analysis of PCA was (1) data preparation, (2) observed correlation matrix infection, (3) statistics to the asses suitability of dataset for basis of PCA, (4) factor extraction, (5) factor rotation, (6) factor name attribution, (7) factor score interpretation.

3. RESULTS OF ANALYSIS

We began data analysis by examining of relevant summary of descriptive statistics (Table 1).

Table-1. Summary of descriptive statistics of the research data

Description	Variables								
	Y	X1	X2	X3	X4	X5	X6	X7	X8
Mean	34.98	33.87	1.50	3.85	45.15	31.93	2.90	3.08	31.67
Standard Error	0.53	0.79	0.03	0.09	0.92	0.91	0.06	0.07	0.49
Median	35.00	34.00	1.50	4.00	45.00	32.00	3.00	3.00	20.00
Mode	35.00	34.00	1.50	3.00	30.00	17.00	3.00	4.00	15.00
Standard Deviation	7.73	9.43	0.46	1.24	13.33	13.19	0.89	1.06	7.09
Sample Variance	59.69	130.73	0.21	1.55	177.57	174.09	0.79	1.13	50.32
Kurtosis	-0.51	0.28	0.06	-0.09	-0.49	-0.69	0.28	-0.97	-0.42
Skewness	0.03	-0.11	-0.01	0.59	0.35	0.34	0.25	-0.13	0.94

Table - 1 shows the results of measuring the central tendencies that provide a convenient way to describe the data with a single number of the mode, the median, and the mean. Although the modes of X5 and X8 are significantly different with the means and the medians, we can say that data presenting the meaningful means. This is in line with the values of kurtosis and skewness that indicate that the means fall into normal distribution curves. Furthermore, in the fifth line of the table above shows the counterparts of the central tendencies those are the standard deviations. The counterpart indicates that 99% of the scores of data are in the range of the normal distribution.

Comparing tree shade value or WTA (Y) with variable lost (X1), they have nearly similar means and central tendencies but more different of standard deviations. Mean of Y is greater than the mean of X1 and this in line with equation 3. Almost all scores of Y fall between 11.8 (IDR 11,800.00) and 58.2 (IDR 58,200.00) meanwhile all scores of X1 are in between 5.7 (IDR 5700.00) and 68.2 (IDR 68,200.00). This implies that the scores belong to Y are closer together than the scores belong to X1. Similar means are in the X5 and X8 variables, but quite different on standard deviations where scores of X8 are closer together than scores of X5.

In the theoretical framework we have explained the demographic and economic factors (S) as one of the determining factors for the utility expression. The S factor in this research consists of six variables (X2, X3, X4, X5, X6, and X7). While X1 representing L factor and X8 representing Q factor. The complexity of the variables is interesting and suitable for using Principle Component Analysis as a widely used mathematical tool for height dimension data analysis. We agree to use this method in order to have a good regression equation that simpler and easier to understand. The linear regression assumption is that the independent variables are not significantly correlated.

Correlation matrix as presented in Table 2 is a starting point of PCA, in which the inter correlations between the studied variables are presented. The analysis clumped subgroups of the variables together and try to get a feel for what the factors were going to be just by looking at the matrix and spotting clusters of height correlation between groups of variables. We used the coefficient correlations (Pearson's product-moment) to measure the degree or the strength of the relationship.

Table-2. Pairwise correlation of the variables

	X1	X2	X3	X4	X5	X6	X7	X8
X1	1.00							
X2	0.95	1.00						
X3	-0.17	-0.13	1.00					
X4	-0.07	-0.04	0.36	1.00				
X5	-0.05	-0.04	0.29	0.95	1.00			
X6	0.35	0.35	0.12	0.52	0.50	1.00		
X7	0.29	0.27	0.25	0.67	0.69	0.61	1.00	
X8	0.82	0.80	-0.06	0.01	0.00	0.31	0.25	1.00

The above table shows positive and negative coefficients. A positive coefficient presents a direct correlation, while a negative coefficient presents an inverse correlation. Variable X1 for example, presents direct correlations with X2, X6, X7, and X8, while the rest are the inverse correlations (X3, X4, and X5). We have just X6 and X7 that present direct correlation with other variables, while the rest present both direct and inverse correlations. Beside the sign of the correlations, we have as well as the magnitude describing the strength of the correlation. By considering all X variables, we can categorize 15 coefficients presenting weak correlation ($0<|r|<.3$), 8 coefficients presenting moderate correlation ($.3<|r|<.7$), and 3 coefficients presenting strong correlation ($|r|>.7$). The highest is 0.95 of Lost (X1) with Land owned (X2) correlation, while the lowest is 0.0 (there is no correlation) of X5(gardening experience) with X8(max. Shade allowed). The matrix shows the same sign and magnitude of the relationship (-0.04) presenting by X2, X4, and X5.

Among all coefficients of the simple correlation, there are three coefficients with values ≥ 0.8 then we can diagnose that there is multicolinearity between variables. Multicolinearity can be detected by more ways, such as looking at the determinant of the R-matrix, tolerance coefficient and the variance inflation factor (VIF). The SPSS output shows four variables with <1 of tolerance and > 10 of VIF (X1, X2, X4, X5). To persuade by using PCA, we pursued KMO test (Kaiser-Meyer-Olkin) and Bartlett’s Sperichity Test. Sampling adequacy of Kaiser-Meyer-Oikin measure is 0.733 while significancy of Bartlett’s test of sphericity is 0.000. The KMO index by measuring, sampling adequacy (MSA) compared the value of correlation between variables and those of partial correlation. Due to the KMO index is high, the PCA can act efficiently.

The Bartlett’s test checked if the observed correlation matrix diverged significantly from the identity matrix. In order to measure the overall relationship between the variables, we computed the determinant of the correlation matrix |r|. Under Ho, $|\mathbf{r}|= 1$; if variables are highly correlated, we have $|r|= 0$. The result indicated to reject the null hypotheses at the 5% level (p-value= 0<0.05). We can perform efficiently PCA on the data set. Both KMO index and the Bartlett’s test allowed to make a summary of information provided by the initial variables in a few number of factors. Anti Image Matrix worked to decide which variables will be included in the PCA, and it gave results that we have good values for all variables for the MSA (>0.5).

To extract the principle components, we used a scree test as a device for deciding on the number of components to retain. The scree test is a plot with the eigenvalues on the ordinate and the component number on the abscissa. In a scree plot, scree is those components that are at the bottom of the sloping plot of eigenvalues versus component number. For each principal component, the corresponding eigenvalue is plotted on the y-axis. The plot provides a visual aid for deciding at what point including additional components no longer increases the amount of variance accounted for by a nontrivial amount. By definition the variance of the components is smaller than the preceding one. Here is the scree plot produced by the SPSS (Figure 3):

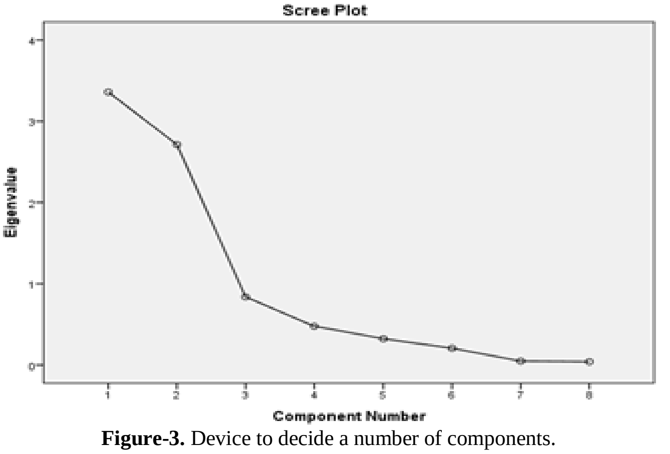

Figure-3. Device to decide a number of components.

Due to the curve shows an "elbow" at 2 to 3 values on the component number axis, this was taken as indicating that higher order principal components contribute a decreasing amount of additional variance and so might not be needed. Here there appears to be marked decrease in downward slope after the second principal component implying that we can summarize the eight variables by the first two principal components. There is a big drop in eigenvalue between component 2 and component 3. The two components have eigenvalues greater than 1. The two principal components account for 76% of the total variance.

The principal component scores of selected components (C1 – C8) are used as predictor variables for OLS regression analysis. The results revealed that multicollinearity was removed and only C1 and C2 were found to be statistically significant, as shown in Table 3.

Tabel-3. OLS Regression based on principal component scores

Predictor	Coefficient	SE	T	P	VIF
Constant	35.05	2.41	9.36	<0.001	1.00
C1	3.11	1.97	23.46	<0.001	1.00
C2	7.0	0.47	2.65	0.01	1.00

We name C1 as ecology-economic (Fee) and C2 as socioeconomic (Fse). The model can be written as:

$$Y= 35.05 + 3.11\ Fee + 7.0\ Fse + \varepsilon \qquad (4)$$

Where Y is the tree shade value as dependent variable that we were trying to predict, Fee (ecology-economic factor) and Fse (socioeconomic factor) are independent variables we have used to predict Y; where Fee= f(X1, X2,X8) and Fse= f(X3, X4, X5, X6, X7). The equation shows that 35.05 of the Y-intercept can be interpreted as the value that we would expect an average the tree shade value of IDR 35.05 (x IDR 10,000.00) if both Fee and Fse are zero. The coefficient of ecology-economic in the unit is IDR 3.11 (x IDR 10,000.00). The coefficient indicates that for every additional unit in ecology-economic factor we can expect the tree shade value (Y) to increase by an average of IDR 31,100.00. Similarly, 7.0 is interpreted as the difference in the predicted value in Y for each one-unit difference in Fse, if Fee remains constant.

The coefficient of multiple determination is 0.919; therefore, about 91,9% of the variation in the tree shade value is explained by ecology-economic factor (Fee) and socio-economic factor (Fse). The regression model appears to be very useful for making predictions since the value of R^2 is close to 1.

One of the most basic results of the research is indicated by equation 4 that shows how natural and social aspect of the tree shade value in the perspective of economic interest will contribute to establish a concept of sustainable development into REDD+ implementation based cocoa Agroforestry systems. Even though the two factors give positive contribution to tree shade value, they have different parameter values that reflect the weighting of the factors in determining the utility for the tree shade value in the form of WTA. When utility are measurable in monetary WTA compensation, the parameters represent the marginal monetary value of each characteristics [17].

Mean of the tree shade value is IDR 35,000.00 per month per one percent of additional shade in one hectare cocoa agroforestry. Table 1 shows us the mean of tree shade allowed by respondents is 31.67%, while minimum and maximum shade allowed are 19% and 42%. Mean of actual tree shade practiced by the farmers is 18%. By enhancing tree shade or cover will increase the environmental global function and this make farmers have an opportunity to earn new cash from REDD+ mechanism. Agroforestry has been recognized by Intergovernmental Panel on Climate Change as having potential for sequestering carbon as part of climate change mitigation strategies [18]. Not only its global function, agroforestry also can play its local role in improving livelihood as it offers multiple benefits and opportunities to farmers to improve land production and incomes.

Tree shade will give advantage to eight years old of cacao plants under the trees *(Albizia sp)* by increasing cocoa biomass and nutrient uptake [19]. Aboveground dry matter of cocoa increased with shade, and declined along a spatial gradient away from shade trees. Light availability under the shade trees was within the optimal range for cocoa production. Most aspect of nutrient cycling will be directly affected by the choice of shade species since these species differ significantly in aboveground biomass productivity, rate of biomass decomposition and fine root biomass productivity [2].

Average yield of cocoa per hectare of the full sun, low shade, medium shade and heavy shade are 794 kg/ha, 696 kg/ha, 735 kg/ha and 546 kg/ha respectively [20]. The yield under the full sun system shows a sharp rise in the yield and followed by a very sharp fall in the yield after age 16. The medium shade has a gradual yield till it peaks at age 19 followed by a gradual fall in yield till age 80. Even though medium shade level have good enough yield but less than the full sun, farmers in many parts of the world, including in the research site are converting shaded cacao into unshaded monocultures to increase short-term income.

4. DISCUSSION ON THE PERSPECTIVE OF REDD+

Recognition to allow tree shade in cocoa Agroforestry up to 32% is a strong factor of this land use system to be one of REDD+ activities in Central Sulawesi Province. Although the pristine natural forest ecosystem represents the largest vegetation and soil C sinks, the need for transforming some of the lower biomass land uses to carbon-rich tree based system such as Agroforestry therefore assumes significances. In Central Sulawesi as well as in diverse ecoregions around the world, agroforestry systems with more than one billion hectares, has a special relevance in this respect of REDD+ implementation. Agroforestry, due to its woody perennial arrangement has relatively high ability for catching and collecting atmospheric CO_2 in vegetation, soils, and biomass products. C storage in plant biomass is only feasible in the perennial agroforestry systems, which allow full tree growth and where the woody component represents an important part of the total biomass [21]. The trees in agroforestry can be also viewed as “stored capital” providing economy and ecology benefits if the families are in need, as well as in reducing vulnerability to environmental, economic or social shock, e.g. dramatically falling prices as was the case in cocoa in the late 1980s to early 1990s [5].

A worked on acceptance of climate change by rural farming in Nigeria gives a conclussion that the acceptance is manifested in form of climate change awareness by the farmers [22]. It was explained furthermore the role of science as essential part for the success of future farming in the region. A supporting statement that knowledge gaps and limited capacities inhibit the timely and large scale implementation of REDD+ Hamakers, et al. [23]. Capacity gaps and large data has to be addressed in order to have REDD+ outcomes can be measured, reported on and verified (MRV).

REDD+ will make a delivery of economic resources from carbon offset buyer to seller with payments being conditional on the acceptance of sustainable land management and transfer of carbon sequestration or emission mitigation against national or project-based baselines. To build cacao Agroforestry ecosystem services the basic of the carbon conservation strategies is to place – intentionally or otherwise- that the Agroforestry is only worth conserving when it is profitable. Administering the Agroforestry for the providing of its ecosystem services requires of continuously perform in order to warranty emerging trade-off across spatial and temporal scales, and to track changes in local well-being in the short and long term. We are sure that cocoa Agroforestry can provide for mitigation of global warming and climate change as well as in the same time producing multiple benefits to the owners who are revealed to the decreased production, high disease burden, climate variability, poverty, land degradation, and forest encroachment.

Persistent willingness to grow the spirit of REDD+ based cocoa Agroforestry in existing policies such as farm forestry and forest management unit in Indonesia has to be a good combination of strength and opportunities of cocoa Agroforestry in supporting REDD+ implementation. Through the contexts, the farmers should achieve their needs by gathering multiple benefits of the Agroforestry and having positive participation and new income from the mitigation of climate change due to carbon accumulation in the tree biomass of the Agroforestry. In the context of farm forestry, the farmers will be key as the actors, while in the context of the forest management unit, they can be the key participants in forest management.

Evidence of the results and existing theories, we present scenarios of REDD+ implementation based cocoa Agroforestry with eighty years of the project period as being shown by Figure 4. We have four curves and one line in the graph, which are curves A, A', A'' presenting yield and or value of cacao under full-sun, and curve B presenting yield and or value of cacao Agroforestry under medium shade. We proposed line L as a reference line of tree shade compensation.

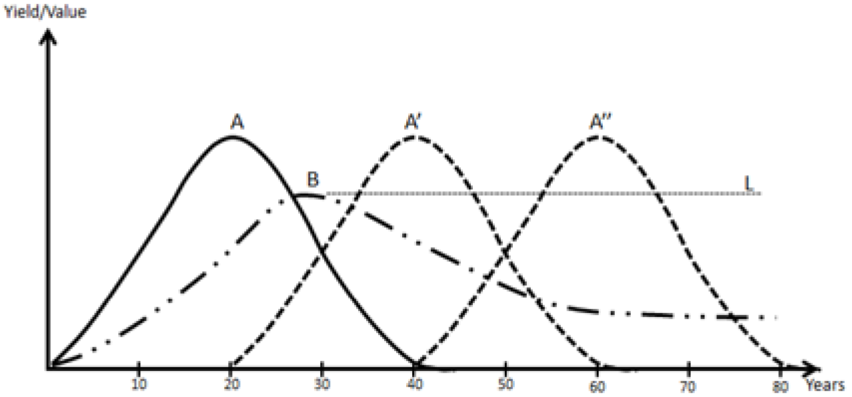

Figure-4. Scenario of REDD+ implementation based cocoa Agroforestry (B), with full sun cacao as reference (A).

Value of tree shade compensation could be above or below L line. It depends on whether cocoa Agroforestry is implemented in forest area or in private land. In the private land, a farmer could make cacao plantation by Scenario A and prepare to make replantation when the yield or value decreasing (A', A''). In the other word, the farmer is not under REDD+ policy and keep his preference of maximizing cacao production.

Under REDD+ program, cocoa agroforestry could be as a climate-smart agriculture of conservation agriculture in order to deliver significant carbon mitigation and reduced greenhouse gas emission. By referring on some results of researches, it has reported in FAO Working Paper that agroforestry could sequester up to 19 tones C ha^{-1} $year^{-1}$, depending on the type, location and management regime [24].

5. CONCLUSION

We hope to have been providing a relevant work supporting REDD+ policy and implementation. This work will be as a social acceptance of the farmers to this global awareness. This local social acceptance has been in the model describing socio-economic-ecological dimension of sustainable development values. We are glad to know that the thought of the farmers has been maintained by those dimension values. With respect, we expect to have highlighted relevant points for a REDD+ research agenda which is both scientifically and politically relevant.

6. ACKNOWLEDGEMENTS

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REFERENCES

[1] P. F. Donald, "Biodiversity impacts of some agricultural commodity production systems," *Conservation Biology,* vol. 18, pp. 17–37, 2004.

[2] J. Beer, R. Muschler, D. Kass, and E. Somarriba, "Shade management in coffee and cacao plantations," *Agroforestry Systems,* vol. 38, pp. 134–164, 1998.

[3] A. Rifin, "Competitiveness of Indonesia's cocoa beans export in the world market," *International Journal of Trade, Economics and Finance,* vol. 4, pp. 279-281, 2013.

[4] R. Ashare, "Cocoa agroforestry in West Africa: A look activities on preferred trees in the farming systems." Forest and Landsecape Working Papers No. 6, 2005.

[5] T. Tscharntke, Y. Clough, A. S. Baghwat, D. Buchori, H. Faust, D. Hertel, D. Holcher, J. Junrbandt, M. Kessler, I. Perfecto, C. Sceber, G. Schroth, E. Veldkamp, and C. T. Wenger, "Multifunctional shade-tree management in tropical agroforestry landscapes – a review," *Journal of Applied Ecology,* vol. 48, pp. 619-629, 2011.

[6] P. Schroeder, "Agroforestry system: Integrated land use to store and conserve carbon," *Climate Research,* vol. 3, pp. 53-60, 1993.

[7] C. Epple and T. Julia, *Option for REDD+ action: What are their effects on forests and people?: An introduction for stakeholders in central Sulawesi*, 2nd ed. Cambridge, UK: UNEP-WCMC, 2013.

[8] C. Bann, *The economic valuation of tropical forest land use option: A manual for researchers*. Singapore: EEPSEA-IDRC, 1998.

[9] D. Moran and C. Bann, "The valuation of biological diversity for national biodiversity action plans and startegies: A guide for trainers," presented at the Prepared for the United Nation Environmental Program, UNEP, 2000.

[10] M. Barrio and M. L. Loureiro, "A meta-analysis of contingent valuation forest studies," *Journal Ecological Economics, Elsevier,* vol. 69, pp. 1023-1039, 2010.

[11] A. Ozturk, M. F. Turker, and M. Pak, "Economic valuation of externalities linked to Turkish forests," *African Journal of Agricultural Research,* vol. 4, pp. 1251-1259, 2009.

[12] K. Paustian, J. Six, E. T. Elliott, and H. W. Hunt, "Management options for reducing CO2 emissions from agricultural soils," *Biogeochemistry,* vol. 48, pp. 147–163, 2000.

[13] World Resource Institute: Climate Analysis Indicator Tool (CAIIT), "Navigating the number greenhouse gas data and international climat policy." Available www.lowcarboneconomy.com, 2005.

[14] E. Somarriba, C. Rolando, C. Luis, C. Miguel, D. Hector, Z. Tania, M. Henry, A. Guadelupe, A. Estefany, P. Veronica, A. Carlos, S. Eduardo, and D. Oliver, "Carbon stock and cocoa yileds in agroforestry system of central America," *Journal of Agriculture, Ecosystems and Environment, Elsevier,* vol. 173, pp. 46 – 57, 2013.

[15] P. Riera, G. Signorello, M. Thiene, P. A. Mahieu, S. Navrud, P. Kaval, B. Rulleau, R. Mavsar, L. Madureira, J. Meyerhoff, P. Elasser, S. Notaro, M. Salvo, M. Giergczny, and S. Dragoi, "Non-market valuation of forest goods and services: Good practice guidelines," *Journal of Forest Economics. G Mode JfE-25166, Elsevier,* vol. 12, pp. 1 - 12, 2012.

[16] R. A. Johnson and D. W. Wichern, *Applied multivariate statistical analysis*, 2nd ed. Englewood Cliffs. New Jersey: Prentice Hall, 1988.

[17] S. C. Farber, R. Costanza, and M. A. Wilson, "Economic and ecological concept for valuing ecosystem services," *Ecological Economics, Elsevier,* vol. 41, pp. 375-392, 2002.

[18] R. I. Watson, B. Noble, N. Bolin, D. Ravindran, D. Verardo, and D. Doken, *Land use, land use change and forestry. Intergovernmental panel on climate change*. Cambridge, UK: Cambridge University Press, 2000.

[19] M. E. Isaac, V. R. Timmer, and Q. S. J. Timmer, "Shade tree effect in an 8-years old cocoa Agroforestry system: Biomass and nutrient diagnosis of theopbroma cacao by vector analysis," *Springer Science+Business Media B.V.,* vol. 78, pp. 155-165, 2007.

[20] L. Nunoo, V. Owusu, and O. B. Darko, "Cocoa agroforestry a bridge for sustinable organic cocoa production," in *Proceeding of 4th ISOFAL Scinetific Conference (2014)*, Istambul Turkey, 2014.

[21] A. Albrecht and S. T. Kanji, "Carbon sequestration in tropical Agroforestry systems," *Agriculture Ecosystems& Environment, Elsevier,* vol. 99, pp. 15-27, 2003.

[22] U. A. Ofuoku and N. U. Uzokwe, "Acceptance of climate change by rural farming communities in Delta State, Nigeria: Effect of science and government credibility," *Asian Journal of Agriculture and Rural Development,* vol. 4, pp. 372-380, 2014.

[23] V. J. I. Hamakers, A. Gupta, M. Herold, P. M. Claros, and J. M. Vijge, "Will REDD+ work? The need for interdiciplinary research to adress key challenges," *Elsevier: Current Option in Environmental Sustainability,* vol. 4, pp. 590-596, 2012.

[24] D. Kaczan, A. Arslan, and L. Lipper, "Climate-smart agriculture? A review of current practice of Agroforestry and conservation agriculture in Malawi and Zambia." ESA Working Paper No. 13 – 07. FAO, 2013.