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CAN THE APPLICATION OF AGROFORESTRY AT MONOCULTURAL FOOD CROP AREAS SUPPORT MANUFACTURER CHEMICAL FERTILIZER REDUCTION PROGRAMS WITHOUT SACRIFICING FARMERS' INCOME?

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Abstract
In an agroforestry system, nutrients from the subsoil can be made available to food plants through the absorption process by trees with deep roots. However, shade from canopy tree plants can suppress photosynthesis and reduce food crop production and farmer income [INCM]. This antagonism needs to be evaluated when introducing agroforestry programs into monoculture food crop areas to reduce manufactured chemical fertilizers application. This research was carried out from June to August 2023 at Natar District, South Lampung Regency to determine the effect of tree strata (teak, acacia, and albizia), multi-proposed tree species or MPTS (Parkia speciosa, avocado, and jack fruit), shrubs (coffee and cacao), and ground cover (vegetables, peanut, and soybean) to [INCM]. Interviewing forty respondents who were still retaining one or more of these tree strata among food crops including upland rice, corn, and cassava. The OLS (ordinary least square) model was employed at 90% confidence level. To eliminate the model error, the variables ownership of productive assets (upland, cattle, sheep, and cock), fertilizer application (urea, ponska, KCl and liquid fertilizer), compost, and pesticide use were also incorporated in the model. The results suggest the significant effects: (1) that positive ones are acacia, teak, vegetables, peanuts, and, soybeans, respectively USD 86.4 (P=0.000); 88.3 (P=0.000); 109,5 (P=0.000); 114.6 (P =0.000); 145.1 (P=0.000); and (2) which negative were Albizia falcataria, Parkia speciosa, avocado, coffee, and cacao respectively of around USD 31,7 (P=0.002); 57.1 (P=0.000); 43.2 (P=0.003); 62,0 (P=0.000) and 96.37 (P=0.000).

Keywords Monoculture, MPTS, multi stratum, productive assets, subsistence income.

INTRODUCTION

The use of fertilizer subsidies for food crops has long been a fiscal burden for the Indonesian Government. In the period 2005-2014 to the 2015-2023 period, on average, increased by more than 200% that is from USD 910.3 million USD 2,020.7 per year whereas price fertilizer deep average world second period That down from USD 318,3 increase to USD 313.9 per ton (Ahdiat, 2023). It is estimated that in the next 5 years this will be almost impossible for the government to bear, especially for KCl, which is all still imported. According to Jamilatun et al. (2021) its availability very limited, far away than necessary farmer so that lots the farmer is in pursuit fertilizer non-subsidized though price Far more expensive. On the other hand, the performance of agricultural food products also has no hope of escaping the food trap that is commonly encountered by developing countries (middle-low income) which are undergoing transformation to become industrial countries. The low productivity of food crop agriculture is the impact of previous policies, which began in the 1960-1970s decade.

In decades many developing countries such as Indonesia have experienced food insecurity due to the population explosion of the baby boomer generation accompanied by a decrease in death rates thanks to advances in imported health technology, including pharmaceutical medicine. Policies to accelerate the green revolution have saved many developing countries from becoming middle-income such as Indonesia in the 1990s decade, namely through food self-sufficiency under the green revolution which is still accompanied by an increase in the proportion of the middle class who are able to buy imported food, especially processed food. Import policy is carried out by setting specific tariffs, tariff quotas, and red lines to reduce the number of imports (Dewi, 2018).

Success green revolution in improving the agricultural food sector (which Also able to move the agro-industry sector and other downstream sectors)' it cannot be denied. However, on the other hand, environmental degradation and pollution as a negative externality are also very large.

Implications success revolution green also the increasing demand for improving welfare or progress trapping continues and has led to widespread land extensification for agricultural cultivation, especially for food crops. The conversion of forest lands through deforestation is the implication, followed by damage to the hydro-organological characteristics of upstream areas. This crisis is characterized by increasing frequency of floods in the rainy season and droughts in the dry season, increased erosion, followed by sedimentation in lakes, reservoirs and water bodies accompanied by worsening water quality such as eutrophication. Changes in land use cause changes in watershed flood discharge conditions so that rain drop has the potential to become surface runoff rather than being absorbed by the ground surface (Nurrizqi And Suyono, 2012). It is predicted that this phenomenon will not stop due to pressures in the form of population growth, increasing demand for needs, urbanization, increasing demands for comfort, urban growth and other causes (Rahardjo et al., 2019).

Eutrophication is a reflection of the intensive use of fertilizers and pesticides on agricultural land, the doses of which almost always increase due to erosion due to the increasingly minimal vegetated land, especially tree stratum in areas with steep topography which continue to experience pressure for food cultivation. In this way, the content of soil organic matter continues to decline, the cation exchange capacity of the soil continues to decrease so that nutrients cannot be absorbed by the roots. plant food. Even on land that is sloping or even located upstream most of the nutrients that come from fertilizer are carried away by erosion, causing water quality to deteriorate, including in the form of eutrophication that agricultural lands food in flat areas, there is generally an overdose of certain types of nutrients such as phosphorus due to liming or excessive application Phosphate fertilizers (such as TSP, SP36, or rock phosphate) which cause several micronutrients (such as B, Mo, Cu, Zn, Fe, and Mn) to be precipitated by ligands or anions (H2PO4)-1 or by carbonate ligands (HCO3)-1. Precipitation This cause difficult absorbed by the roots of food plants with shallow root systems such as corn, cassava, yams and upland rice. Farmers' low knowledge about the mechanism of deposition of several nutrients in the soil due to the application of manufactured fertilizers like this has led to their wrong leading behavior, namely continuing to increase the dose. Indeed, at the beginning of the green revolution, which was promoted in the 1960s, increasing doses of manufactured fertilizers can always very sharply increase the productivity of wet tropical soils, which are poor in nutrients because they have experienced advanced weathering (Dai et al., 1989). But now it has become a boomerang, it can deteriorate the nutrient balance in the soil, which means it can reduce productivity or at least the condition stagnant.

This nutrient imbalance is also exacerbated by the low level of soil organic matter because the carry over effect of organic material from forest vegetation that has long been cut down has long since disappeared as implications extensification monoculture food crop farming system its nature. The monoculture system is increasingly widespread applied by food crop farmers because of the annual economic rent per hectare that can be generated by this system is much larger from in the wood cultivation system and plantations included chas e crops such as cacao, coffee, wood sweet, pepper, and nutmeg. Until now the monoculture cultivation system in Indonesia in general without leaving other stands such as bushes, thickets, let alone tree stratum. So that soil organic content generally extremely low. This aggravated behavior always a farmer burn remainder plant Because pushed For increase cropping cycle frequency next . as a result chemical fertility and logical land become also extreme low. Soil physic condition

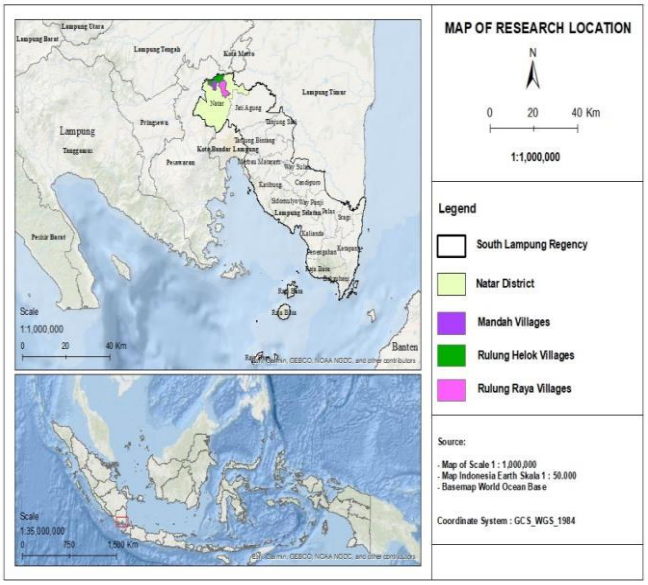
became barren and poor. Finally the revolution green in period long has cause productivity plant food become stagnant and prcause various damage environment. The long food supply chain has been demonstrated to be unable to feed the global population and furthermore, it generates negative ecological, environmental, logistical, and nutritional pressures (Lopez et al. , 2022).

Luckily, in the 1990s there was a reaction that emerged from scientists and practitioners of environmental protection (environmentalism) which showed a lot of scientific evidence about the threat to sustainability of highly specialized monoculture agricultural systems. Instead, they proposed an agroforestry system (agroforestry). This system is an agricultural system that uses multistratum spatially designed plots of land using woody plants or tree stratum, followed by shrub, bush and ground cover stratrum. On surface land, which is integrated with livestock or land fisheries systems in the form of balloons or ponds. This agroforestry system can be applied to develop national food security programs or new food storage (Wattie And Sukendah, 2023). With multistratum like that then can maximize the capture of sunlight for photosynthesis, for production Biomass is very abundant, lots of fallen leaves are rich in nutrients because tree roots are able to absorb nutrients the source rock is quite deep. Falling leaves of tree stratum plants this is when decomposed by micro soil organisms will liberate various macro and micro nutrients that can become natural fertilizers so that they can reduce inorganic fertilizers manufacturer for growing food with shallow roots such as corn, soybeans, beans, sweet potatoes, cassava and vegetables. The decomposition of the leaves also makes soil organisms abundant, meaning there are lots of soil enzymes that make it easier to absorb nutrients means also added then again reducing the need for manufactured fertilizers.

Agroforestry system This In fact, it was typically practiced for centuries by the ancestors of Southeast Asian nations, which have now been largely displaced by modern, highly specialized agricultural systems due to the food crisis in the 1950s responded with policy revolution very green _ massive. Because That until now difficult change behavior waste use fertilizer manufacturer though has give rise to impact negative form stagnation productivity plant food nor various damage environment that. Related with background behind the so necessary problems _ solved through study This are: types of tree stratum What only one can give impact on enhancement income from plant food. As for objective from study This is For do evaluation to a number of type plant in the stratum of influential trees, shrubs and ground cover crops real in increase or lower income from plant cultivated food in agroforestry system .

RESEARCH METHOD

This research was carried out from June to August 2023 in Mandah, Rulung Raya and Banyuwangi Villages, Natar District, South Lampung Regency. Figure 1 provides a sketch of the location of this research is presented.



In accordance with the aim of this research, namely to determine the contribution of woody tree stratum (teak, acacia, and albasia), MPTS (petai or Parkia speciosa , advocado , jackfruit), shrubs (coffee and cocoa), and ground cover (vegetables, soybeans and peanuts). on income derived from food crops, namely cassava, corn and upland rice [Y-FOOD]. Semi-structured interviews were conducted with 40 farmers who still implementing polyculture cultivation with a combination of two or several plant stratum between the food crops. It is important to note that four respondents filled incompletely so excluded in data analysis. shown missing data so excluded In order to determine the influence of each type of the three plant stratum, a linear postulate model, namely OLS (ordinary less square) was applied at 90 and 95% confidence levels. To reduce the influence of variables other than the main variable we are studying, it is necessary to control the error of the model, i.e by incorporating some variables beyond our concern into the OLS model including the variables of ownership of productive assets (ownership of land, cows, sheep and chickens), use of inorganic fertilizers (urea, ponska, KCl, and liquid fertilizer), use of compost and frequency of use of pesticides for 3 years before. Therefore, mathematically the model postulates can be stated as follows:

$$
\begin{aligned}
[\text{INCM}]i = {} & \alpha_0 + \alpha_1[\text{UPLND}]i + \alpha_2[\text{CATL}]i + \alpha_3[\text{SHEEP}]i + \alpha_4[\text{CHOCK}]i \\
& + \alpha_5[\text{PONSK}]i + \alpha_6[\text{LIQOR}]i + \alpha_7[\text{UREA}]i + \alpha_8[\text{KCL}]i \\
& + \alpha_9[D_1\_\text{LEAF}]i + \alpha_{10}[D_1\_\text{MNURE}]i + \alpha_{11}[D_1\_\text{MIXED}]i \\
& + \alpha_{12}[D_2\_\text{RARE}]i + \alpha_{13}[D_2\_\text{FREUQ}]i + \alpha_{14}[D_2\_\text{ALWSY}]i \\
& + \beta_{15}[D_3\_\text{TEAK}]i + \beta_{16}[D_3\_\text{ACSIA}]i + \beta_{17}[D_3\_\text{ALBZ}]i \\
& + \beta_{18}[D_4\_\text{PKIA}]i + \beta_{19}[D_4\_\text{AVDO}]i + \beta_{20}[D_4\_\text{JACKF}]i \\
& + \beta_{21}[D_5\_\text{COFFE}]i + \beta_{22}[D_5\_\text{COCOA}]i \\
& + \beta_{23}[D_6\_\text{VEGTB}]i + \beta_{24}[D_6\_\text{SOYBN}]i + \beta_{25}[D_6\_\text{PEANT}]i + \xi i
\end{aligned}
$$

Equation {1}

In Equation {1}, [Y-FOOD]=income of food crop (USD/family/month), the number the i^{th} respondent,

ξi=residual error, and the symbols are presented in Table 1.

The working hypothesis is depicted as follows:

H_0: $\alpha_1 = \alpha_2 = \alpha_3 \ldots = \alpha_{25} = 0$ → Non of those variables that affect significantly on [INCM]

H_1: $\alpha_1 \neq \alpha_2 \neq \alpha_3 \ldots \neq \alpha_{25} \neq 0$ → At least one of those variables that affects significantly on [INCM].

Table 3. Predictor variables, symbols, unit, and data scoring

Group Predictor Variable	**Symbols**	**Unit**	**Data Scoring**
Predictors			
Productive Asset Belonging			
Uplands	[UPLND]i	Ha	Raw data
Cattle	[CATL]i	Head	Raw data
Sheep	[SHEEP] i	Head	Raw data
Cock	[COCK] i	Head	
Fertilizer Application			
Ponska	[PONSK]i	Kg	Raw data
Liquid Fertilizer	[LIQOR]i	Bottle	Raw data
Urea	[UREA]i	Kg	Raw data
KCl (Kg)	[KCL]i	Kg	Raw data
Green Manure Fertilizer (None=0)			
Leaf Compost	[D_1 _LEAF]i	Dummy	=1 if leaf compost, =0 if others
Manure Compost	[D_1 _MNURE]i	Dummy	=1 if manure compost, =0 if others
Mixed Compost	[D_1 _MIXED]i	Dummy	=1 if mixed compost, =0 if others
Pesticides Appl. Frequency (Never=0)			
Rarely	[D_2 _RARE]i	Dummy	=1 if rare application, =0 if others
Frequently	[D_2 _FREUQ]i	Dummy	=1 if frequently, =0 if others
Always	[D_2 _ALWSY]i	Dummy	=1 if always, =0 if others
Tree Stratum of Wood Tree(None=0)			
Tectona grandis	[D_3 _TEAC]i	Dummy	=1 if rare application, =0 if others
Acacia mangium	[D_3 _ACCI]i	Dummy	=1 if frequently, =0 if others
Albizia falcataria	[D_3 _ALBZ]i	Dummy	=1 if always, =0 if others
Tree Stratum of MPTS (None=0)			
Parkia speciosa	[D_4 _PKIA]i	Dummy	=1 if parkia speciosa, =0 if others
Avocado	[D_4 _AVCDO]i	Dummy	=1 avocado, =0 if others
Jackfruit	[D_4 _JACKF]i	Dummy	=1 if jack fruit, =0 if others
Tree Shrub Stratum (None=0)			
Coffee	[D_5 _CFFE]i	Dummy	=1 if coffee, =0 if others
Cocoa	[D_5 _COCOA]i	Dummy	=1if cocoa, =0 if others
Ground Cover Stratum (None=0)			
Vegetables	[D_6 _VEGTB]i	Dummy	=1 if vegetables, =0 if others
Soybeans	[D_6 _SOYBN]i	Dummy	=1 soybean, =0 if others
Peanut	[D_6 _PEANT]i	Dummy	=1 peanut, =0 if others

RESULTS AND DISCUSSION

The results of the hypothesis test are intended to determine the goodness-of-fit of the resulting model and then proceed to examine each variable studied. Before we examine the results of the role test for each agroforestry stratum chosen as an example in this research, we need

to pay close attention to the goodness-fits test results of the OLS model applied. In Table 2, an analysis of variance is presented accompanied with the R-Sq (adj)

value at the bottom of Table 2.

Table 2 can provide justification that the OLS model applied in this research is very suitable (meets goodness-of-fits) if used to reveal the effect of 25 predictor variables on the response variable. This claim is indicated by the resulting confidence level indicator (P-value=0.000). In addition, almost all of the variance of the response variable [R-Sq (adj)= 96.4%] can be explained by the 25 predictor variables applied in this study. This means that only around 3.6% must be explained by other predictor variables that are not included in this OLS model. Thus, this model can be used as a reference to test the influence of each predictor variable on the response variable that will be revealed in this research, namely sources of income from food crops [Y-FOOD]. In Table 3, the results of testing model parameters are presented.

Table 2 . The Analysis of Variance

Source	DF	SS	M.S	F	P -value
Regression	25	90.352	3.6141	36.67	0.000
Residual Error	11	1.002	911		
Total	36	91.354			
S = 9.54504		R-Sq = 98.9% and R-Sq(adj) = 96.4%			

The Role of Productive Asset Ownership

In order not to cause major errors in investigating the influence of various main variables, the influence of asset ownership on [Y_FOOD] needs to be set aside separately, namely the ownership of upland, cows, sheep, and chickens number. As can be seen in Table 2, if other variables remain constant, then increasing in ownership of 1 ha of UPLND, will followed by farmers' income from food crops as much as USD 27,138/family/month, which the confident level is more than 99.999% (P= 0,000). This means that the working capacity of farmers in the research area can still be increased through land extensification. Even so, the policy of increasing the UPLND area is not a realistic option to be implemented.

The other productive assets are livestock, namely cows, sheep and chickens. The results of this research prove that the number of cow ownership does not have a significant effect on income from food crop sources [Y_FOOD]. On the other hand, the number of sheep and chicken ownership can increase the [INCM] by USD 5,589 (P=0.000) and USD 1,014 (P=0.001) per family/month respectively for each added up of these animals.

This finding is related to the by-products from livestock farming, namely manure which is generally used as soil amendment. In subsistence families in Indonesia, cows are generally used every day to cultivate the land, they are not released into the wild, so the grass they feed on is also not diverse. By itself, the nutrient content of cow dung also does not vary. Different from sheep or chicken. These two livestock are generally released into the wild, which causes diversity in their feed intake so that the nutrient levels in their manure are also richer and more varied than those of cows. With these differences, the productivity of food crops is better in families that have lots of sheep and chickens than those whose cows.

Table 3. Hypothesis testing results using T statistics

Group Predictor Variables Predictor	**Symbols**	**Coef.**	**SE Coef.**	**T**	**P**
Constant	-	4.96	16.62	0.30	0.771
Productive Asset Belonging					
Upland (ha)	[UPLND]i	27.138	5.380	5.04	**0.000**
Cow (head)	[CATL]i	2.437	3.276	0.74	0.473
Sheep (head)	[SHEEP] i	5.589	1.120	4.99	**0.000**
Chicken (head)	[COCK] i	1.014	0.229	4.44	**0.001**
Fertilizer Application					
Ponska (Kg)	[PONSKA]i	-0.049	0.029	-1.69	0.120
Liquid Fertilizer (Bottle)	[LIQOR]i	0.067	0.007	9.28	**0.000**
Urea (Kg)	[UREA]i	0.099	0.034	2.91	**0.014**
KCl (Kg)	[KCL]i	2.549	1.318	1.93	**0.079**
Green Manure Fertilizer (None=0)					
Leaf Compost	[D_1 _LEAF]i	26.740	11.270	2.37	**0.014**
Manure Compost	[D_1 _MNURE]i	30.890	6.126	5.04	**0.000**
Mixed Compost	[D_1 _MIXED]i	53.815	8,169	6.59	**0.000**
Pesticides Application Frequency (Never=0)					
Rarely	[D_2 _RARE]i	0.229	8.615	0.03	0.979
Frequently	[D_2 _FREUQ]i	-0.614	6.481	-0.09	0.926
Always	[D_2 _ALWSY]i	-32.320	12.65	-2.56	**0.027**
Tree Stratum of Wood (None=0)					
Tectona grandis	[D_3 _TEAK]i	86.381	8.395	10.29	**0.000**
Acacia mangium	[D_3 _ACSIA]i	88.294	9.158	9.64	**0.000**
Albizia falcataria	[D_3 _ALBZ]i	-31.725	8.049	-3.94	**0.002**
Tree Stratum of MPTS (None=0)					
Parkia speciosa	[D_4 _PKIA]i	-57.095	7.441	-7.67	**0.000**
Avocado	[D_4 _ADVC]i	-43.208	7.670	-5.63	**0.000**
Jackfruit	[D_4 _JACK]i	-13.470	10.05	-1.34	0.207
Tree Shrub Stratum (None=0)					
Coffee	[D_5 _COFFE]i	-61.99	16.50	-3.76	**0.003**
Cocoa	[D_5 _COCOA]i	-96.37	-13.38	7.20	**0.000**
Ground Cover Stratum (None=0)					
Vegetables	[D_6 _VEGTB]i	109.49	13.17	8.32	**0.000**
Soybeans	[D_6 _SOYBNs]i	114.60	11.17	10.26	**0.000**
Peanut	[D_6 _PEANT]i	145.07	13.66	10.62	**0.000**

The Effect of Fertilizer Application

Only ponska from the 4 types of manufactured chemical fertilizer applications did not have a significant effect (P=0.120) on the [INCM], while urea and liquid fertilizers were very significant (P=0.000 and P=0.014 respectively) and potassium chloride fertizer (KCl) was significant (P=0.079). Liquid fertilizer apart from containing macro-nutrients (N, P, K, Ca, Mg) also contains micro-nutrients such as Fe, Zn,

and Cu. Although the N, P, and K nutrients in this liquid fertilizer are not as much as in Ponska fertilizer, it seems that the content of Ca and Mg is a factor that leverages soil fertility and food crop productivity, the content of several micro-elements Fe, Cu and Zn are used to increase and balance nutrient content as variables that are quite important for increasing the status of soil fertility and food crop productivity.

If this is the case, it means that the status of micro-nutrients, especially Fe, Cu and Zn, has experienced a deficiency. This possibility could occur considering that the study area has been used as an exhaustively used as monoculture food farming area since the green revolution in the 1960s, although some areas have become similar to agroforestry systems recently. Since the green revolution program, TSP (CaH2 PO4) fertilization has been carried out intensively, which has resulted in the deposition of many micro-elements in the soil. Therefore, even though the study area is tropical soil that has experienced advanced weathering (Dai et al., 1989), it can cause the availability of micro-nutrients for plants to be very low. The use of organic fertilizer and compost can generally restore the availability of various nutrients, including micro-elements.

Effects of Compost Application

Judging from the composition of the raw materials used, there are 3 types of compost commonly used by farmers in the research area, namely produced from plant residues [LEAF], livestock manure [MNURE], and a mixture of both [MIXED]. As can be referenced in Table 2, each can increase [INCM] by around USD 26,740 (P=0.014); 30,890 (P=0.000); and 53.815 (P=0.000). The use of MIXED has the greatest effect. These findings confirm that many ligands are released from organic materials that have undergone decomposition, including phenol, carboxyl, carbonyl, urea, amine, amino, etc. These ligands, actually as the various functional groups that carry a lot of negative electrical charge which can increase the level of soil chemical fertility through the mechanism of increasing the cation exchange capacity (CEC), as well as increasing cation retention and the availability of nutrients in the top soil layer, particularly the cations of K. Ca, Mg, Fe, Zn, Cu etc. This retention means that these various cations are not easily leached by water that sees into the lower soil layer so that they are widely available to food plants that have a shallow and wide horizontal root distribution.

Apart from its contribution to increasing the chemical fertility level of the soil, organic material from compost can also increase the biological fertility of the soil, both macro fauna (worms, insects, ants, etc.) and micro fauna (bacteria, algae, and fungi), especially those originating from livestock manure compost. The addition of organic material will increase the nutrients in the soil so that its content becomes better (Mulyadi et al., 2022). The by-product of the work of biological creatures in order to extract energy from organic material, apart from producing various ligands, also produces various soil enzymes. The bio-catalyst role of enzymes in soil includes controlling mycorrhiza in dissolving phosphate which generally in tropical soils is bound as occluded by sesquioxide complex compounds or by calcium and magnesium cations in soils that have experienced intensive application of liming and application of TSP, SP 36, or rock phosphate since the green revolution program.

Besides increasing the chemical and biological fertility of the soil, the effect of compost also occurs through improving the physical condition of the soil. Various ligands resulting

from compost decomposition that have a negative electrical charge (such as phenol, kabox , carbonyl, etc.) can bind soil clay minerals that have a positive electrical charge, including sesquioxidase (Fe2O3XH2O, and Al2O3XH2O), limonithe, and hydragilithe to form soil aggregates. On the other hand, various ligands that have a positive electrical charge such as amide, amine, amino etc groups can bind negatively charged clay particles such as kaolinite, illite , montmorillonite etc. The role of ligands with both positive and negative electrical charges in forming soil aggregates also has an impact on increasing total porosity in the soil system. Increasing these physical properties of the soil also has an impact on improving the circulation of water and air in the soil, which means it makes it more favorable both for crop roots and for biological life in the soil, then stimulates biochemical processes in the soil, improves nutrient uptake, plant yields and ultimately increases [INCM]. As depicted in Table 2, because composed by the most diverse materials, the use of MIXED compost has the greatest effect on increasing [INCM] compared to [LEAF] and [MNURE]. Organic compost can improve soil structure, increase the soil's water absorption capacity, improve living conditions in the soil, and contain nutrients for plants (Sagitarini and Dewi , 2023) .

Impact of Pesticide Use Frequency

As part of the legacy of the Green Revolution program, the use of pesticides by farmers is difficult to reduce, and their dependence tends to pesticide application increases persistently. The results of this research prove that farmers who always use pesticides in cultivating food crops experience a very significant decrease in their [INCM] which is around USD 32,320 (P=0.027) compared to those who have never applied it again for at least for 3 years ago. The large number of active ingredients in pesticides can deteriorate various biological species which has a direct impact on the natural enemies disappearing thereby increasing resistance to pesticides. Crop failure due to planthopper attacks is a complaint often expressed by farmers, especially in rice fields. One form of policy for managing the quality of agricultural products is regulating legal food safety through determining the maximum level or limit of pesticide residues on agricultural products as an effort to ensure food safety, increase product competitiveness and control imports (non-tariff barrier) (Amilia et al., 2016).

Impact of Wood and MPTS Stratum

The role of woody tree stratum that has an influence on increasing farmers' income from the food sector [INCM] is teak trees or Tectona grandis and Accasia mangium which is around USD 86.381 (P=0.000) and USD 88,294/family/month (P =0.000) respectively. Meanwhile, Albizia falcataria stands were able to reduce [INCM] by around USD 31,725/family/month (P=0.002). The three species of woods stratum have deep roots so they are able to absorb various kinds of nutrients from the lower soil layers and even down to the regolith horizon, which is a source rock for soil-forming materials that have experienced severe weathering then the upper soil layers. Next, these various nutrients are transported to all parts of the wood plant, including the largest part to the leaf canopy of woody trees or MPTS (multi purpose tree species). The fall of old leaves will release various nutrients to the soil surface along with the decomposition process. If these various nutrients resulting from leaf decomposition are carried by rainwater infiltration into the top layer of soil (and also the lateral movement of groundwater) then these nutrients will be

available and relatively easily absorbed by food crops whose roots are relatively very short. One of the factors to consider in choosing a type is economic factors, namely that it must be able to become a source of income for the surrounding community (Nurung, 2019).

This mechanism for pumping nutrients from the subsoil layer or regolith by the roots of woody plants or MPTS is the main basis for reducing the need for manufactured fertilizers using the extensification of agroforestry cultivation systems. However, not every tree stratum plant or MPTS can be used as a nutrient pumping machine. An obstacle that needs to be considered is the existence of competitive mechanisms in obtaining sunlight, nutrient absorption and water absorption between food plants and the woody plants themselves. Especially when the plant spacing is not arranged properly. As can be seen in Table 3, the woody plant Abizia falcataria , as well as MPTS, especially petai (Parkia speciosa) and avocado (Persea americana), have a contrasting effect with teak plants (Tectona grandis) and Accasia mangium. The types chosen are often used, can provide additional income (economic considerations), are well known, and are easy to breed (Syahbudin et al ., 2017). Farmers' income from the food sector [INCM] will experience a very significant decrease if they use these three types of crops, namely around USD 31.725 (P=0.002), USD 57,095 (P=0.000), and USD 43.208 (P= 0,000) per family per month respectively.

The differences between teak and acacia as well as petai (Parkia speciosa) and avocado can occur due to the arrangement of the location of woody plants and MPTS. Teak and acacia in the study area are generally planted as land boundary plants, such as alley cultivation, and are not spread over food crop land. It seems that with this kind of arrangement there is less competition for sunlight shading, nutrient and water uptake between food plants and tree or wood stratum. With this arrangement, the canopy layer of the tree does not cover the food plants too much so that the intensity and duration of sunlight are sufficient to support optimal photosynthesis in food crop leaves to take place. This arrangement also causes the tree stratum plant roots to not spread laterally and extensively because their roots naturally sink into the lower soil layer and even reach the regolith horizon. This root distribution enables less competition for absorption of nutrients or water with food plants. In this way, food crop productivity increases which in turn also increases [INCM]. On the other hand, albizia, petai and avocado plants are spread across the land along with food crops, reducing food crop productivity then causing a decrease in [INCM].

Impact of the Shrub and Ground Cover Stratum

It is these plant remains and weeding by-products that enable the soil to contain more organic matter, which means increasing soil CEC, retention of various soil cations , as well as increasing soil biodiversity and enzymes in the soil. This increase in soil fertility also has an impact on increasing food crop productivity as well as increasing the [INCM] significantly. This also showed the influence of vegetables, soybeans, and peanuts. Even more special is the ability of soybeans (Glycine max) and peanuts (Arachis hypogaea) to fix N 2 gas from the air through a mutualism symbiotic process with Rhizobium sp bacteria in the roots of legume plants. Understory plants have an important role as part of biodiversity and in controlling the rate of erosion (Kunarso And Azwar, 2013).

This Rhizobium sp bacteria lives in the roots of the leguminosae family (including soybeans, peanuts, alfalfa, gliricidia , petai , etc.) in the

form of nodules on the roots of the legume , the Rhizobium obtains food from the photosynthesis of legumes, whereas legumes, as the host of the Rhizobium sp , obtain a large supply of nitrogen nutrients from the fixation process. The carryover effect of plants and the distribution of soybeans and peanuts can be a source of nitrogen nutrients for food crops which are generally planted side by side with peanuts and soybeans. That's why the effect of starting ground cover of soybeans and peanuts is the greatest in increasing [INCM]. Peanuts are good for ground cover crops on corn plants, because they are very effective in suppressing the population and growth of weeds does not cause competition with corn plants (Husain et al., 2022).

The contribution of each of the three types of stratum to the increase in [INCM] is the three largest of all the 25 variables tested in this study. This also means that these three types of ground cover trees can contribute to an increase in [INCM] which amounts to around USD 369.16/family/month, meaning it can compensate for the decrease in [INCM] due to the introduction of Albazia falcataria, Parkia speciosa, avocado, coffee, and cocoa in agroforestry cultivation system in the study area. This compensation only takes into account the influence of environmental services generated by the agroforestry cultivation system and does not take into account the contribution that comes from the harvest of the three types of ground cover strata, from the shrub stratum and the tree stratum. Likewise, various forms of savings, such as reducing the use of pesticides and fertilizers, will add other benefits as a result of implementing an agroforestry system. Thus, the results of this research can strengthen scientific evidence that the extensification of the agroforestry cultivation system into monoculture food farming areas will bring many benefits apart from benefits in the form of increasing people's income even by reducing dependence on manufactured chemical fertilizers.

CONCLUSIONS AND SUGGESTIONS

CONCLUSION

There are two conclusions that can be drawn from this research:

[1] Types that have a positive effect on income from food crops include: teak, acacia, vegetables, soybeans, and peanuts respectively USD 86.4 (P=0.000), 88.3 (P=0.000), 109.5 (P =0.000), 114.6 (P =0.000), 145.1 (P=0.000); and

[2] Types of plants that have a negative effect include albizia, parkia , avocado, coffee, and cacao respectively USD 31.7/family/ month (P=0.002), 57.1 (P=0.000), 43.2 (P=0.003), 62.0 (P=0.000) and 96.4(P=0.000) respectively.

SUGGESTIONS

There are two realistic suggestions to be given based on the results of this research, namely

[1] Carrying out similar research by taking various other species for each stratum.

[2] The policy of expanding agroforestry as an effort to reduce dependence on manufactured fertilizers requires choosing types of tree, bush and ground cover vegetation that have a positive impact on food sector income.

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