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An Assessment of Agroforestry Systems in Selected Community-Based Forest Management Areas in Laguna, Philippines

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ABSTRACT

Agroforestry has been widely accepted as one of the effective approaches in ensuring sustainability in the uplands. In the Philippines, agroforestry, as a forest management strategy, has been promoted by Community Based Forest Management (CBFM) in response to watershed and forest degradation and climate change. The study assessed the agroforestry systems of CBFM sites in Liliw and Sta. Maria, Laguna focusing on the characterization of agroforestry systems; determination of socio-economic and demographic characteristics of farmers, agrobiodiversity and soil physical and chemical properties for formulation of policy recommendations. The agroforestry systems were characterized based on structure. Soil properties and erodibility were determined through soil sampling, direct on-site measurements and laboratory analysis. Results revealed that farmers practiced shelterbelts/windbreaks-cum live trellis system in Liliw and multilayer tree gardens in Sta. Maria. The agrobiodiversity of agroforestry systems in both sites were moderately diverse for members while low diverse for non-members.

Agrobiodiversity indices of agroforestry systems for CBFM members and non-members in Liliw are 2.58 and 1.98, respectively while CBFM members and non-members in Sta. Maria are 2.72 and 0.78, respectively. Farms in both sites had low soil bulk density and erosion rates with high organic matter, Nitrogen, Phosphorous, and Potassium contents. Regardless of the kind of agroforestry system practiced in the CBFM sites, it has been observed that agroforestry is indeed beneficial for both study sites.

***Keywords* —** Agroforestry system, agrobiodiversity, quadrat method, Philippines

INTRODUCTION

Community-Based Forest Management (CBFM) was adopted by the government as its national strategy to address upland poverty and forestland management. It integrates and institutionalizes the various people-oriented forestry programs and for attaining sustainable forestry and social justice. The Community-Based Forest Management Agreement (CBFMA) is the agreement entered between the government and the local community, represented by the People's Organization (POs). The POs are immediate stakeholders of the forestland resources in the protection and management of forest ecosystem. They are elected by the community to represent them in government programs/project or in talks with other stakeholders. The CBFMA holders have a term of 25 years and is renewable for another 25 years. It allows organized communities to harvest timber from plantations and second-growth forests subject to existing regulations on timber harvesting, on the condition that the area will be protected and managed according to the principles of sustained-yield forest management. Forest Management Bureau (FMB) of the Department of Environment and Natural Resources (DENR) indicates that 690,687 households are involved in the implementation of the CBFM program (Lasco & Pulhin, 2006). Accordingly, at an average size of about six persons per household in the Philippine uplands, around 4.14 million people are potential direct beneficiaries of the program (Lasco & Pulhin, 2006). As of 2015, there are 1,093 PO's/CBFM holders nationwide participating in different programs of the DENR (DENR, 2015).

Agroforestry is considered as a major component of government policies and programs in the uplands and the main alternative system in response to the problem of shifting cultivation in the uplands (Nera, 1997 as cited by Lasco

& Pulhin, 2006). It is one of the development activities in the CBFM areas including natural forest management and degraded land rehabilitation (Lasco & Pulhin, 2006). The main goals of the activities are to promote ecological stability and provide livelihood to local communities (Lasco & Pulhin, 2006). It was implemented to rehabilitate the degraded uplands, through involvement of the upland communities, as well as the improvement of the socioeconomic well-being of the community to combat poverty.

This study aimed to present the assessment of agroforestry systems to determine the socioeconomic and demographic characteristics, characterize the agroforestry systems and determine the soil physical and chemical properties under the different agroforestry systems of selected CBFM sites in the province of Laguna.

MATERIALS AND METHODS

The CBFMA areas awarded to the Liliw Upland Farmers Marketing Cooperative (LUFAMCO) in Brgys. Luquin, Ilayang Sungi and Novaliches, Liliw, Laguna and Parang ng Buho Upland Farmers Association (PNBUFA) in Brgy. Parang ng Buho, Sta. Maria, Laguna were selected as the study sites (Figure 1). The criteria used for the selection of the study sites were accessibility, difference in elevations, similar climatic type, length of operation (at least 10 years), willingness of the farmers to participate and differences in agroforestry practices. Moreover, unstable peace and order conditions in other CBFM sites in conducting and facilitating the monitoring and measurements of data as well as limited resources were also considered.

Liliw has an elevation ranging from 400 to 800 m above sea level with undulating topography and slopes range is from 0 to over 15%. About 76.4% of its total land area (4,339.52 hectares) is devoted to agricultural production (Office of the Municipal Mayor,n.d.). LUFAMCO, the people's organization in the study site, was organized in 2002 with total members of 47 farmers who reside in Nagcarlan and Liliw, Laguna (DENR-CALABARZON, 2012). The CBFMA awarded to the PO has a total area of 360 hectares and is classified as timberland that is adjacent to and right outside the Mts. Banahaw-San Cristobal Protected Landscape (MBSCPL) (DENR-CALABARZON, 2012). It has a rolling slope and elevation of 500-900 meters above sea level. It covers the Barangays of Luquin, Ilayang Sungi and Novaliches, all in the municipality of Liliw. The CBFM area has 200 hectares of vegetable farms, 10 hectares of grassland and 150 hectares of secondary growth forest.

Sta. Maria is a fourth class municipality located in the northernmost part of the province of Laguna. The Parang ng Buho Upland Farmers Association (PNBUFA) at Brgy. Parang ng Buho is the people's organization awarded with the CBFMA in Sta. Maria, Laguna. The organization is comprised of 17 farmers who reside adjacent to the farm. The CBFMA awarded to the PO has a total area of 330.64 hectares comprising of 254 hectares of agroforestry/cultivated farms, 50 hectares of grassland, 24.21 hectares of forestland and 2.43 hectares of residential area. It has a rolling slope and elevation of 300 to 400 meters above sea level.

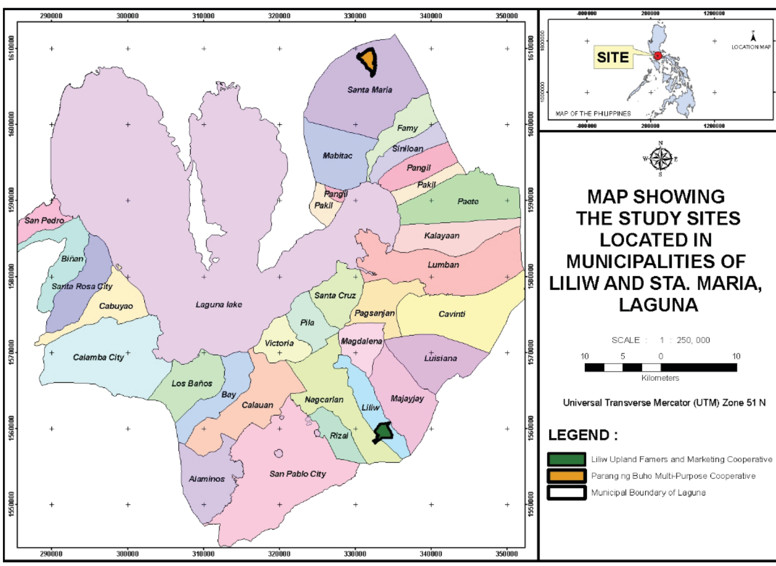

Figure 1. Schematic map representing the location of Liliw Upland Farmers Marketing Cooperative (LUFAMCO) in Liliw, Laguna and Parang ng Buho Upland Farmers Association (PNBUFA) in Sta. Maria, Laguna.

The researcher characterized the agroforestry systems of the CBFM areas through inventory of floral components and were categorized using the classification of agroforestry system by Nair (1989) based on its structure. The structural basis for classification refers to the composition of components, including spatial admixture of the woody component, vertical stratification of the component mix and temporal arrangement of the different components. Nair (1989) classified the agroforestry system based on the components whether agrisilvicultural, silvopastoral or agrisilvopastoral. Agrisilvicultural system contains annual crops and trees including shrubs. The silvopastoral system consists of pasture/animals and trees while the agrosilvopastoral system includes all components like annual crops, pasture/animals and trees.

Farms of both members and non-members of the CBFM were surveyed and described. Since most of the socio-economic indicators to be estimated were in the form of proportions, Cochran (1963:75) formula was used to determine the minimum number of representative samples. Using a 95% confidence level, ±3% precision level, and p=0.99, the computation recommended minimum samples of 35 out of 51 total member households and 69 out of 25 non-member households for inclusion in the study.

Stratified random sampling was applied to randomly select the household samples for the study. In this study, the researcher employed the proportional allocation scheme. This allocation scheme involves the distribution of the sample size within a stratum proportional to the total size of the stratum (Table 1).

Table 1. The minimum and actual number of samples for the study

CBFM SITE	MEMBERS		NON-MEMBERS	
	Minimum Samples	Actual Samples	Minimum Samples	Actual Samples
Liliw	24	28	44	45
Sta. Maria	11	14	25	35
Total	35	42	69	80

Agrobiodiversity Analysis

Prior to the actual biodiversity assessment, the researcher conducted reconnaissance survey of the study sites. The area was delineated based on the results of the characterization. Three (3) representative farms for both PO members and non-members were chosen based on elevation (Figures 2 and 3).

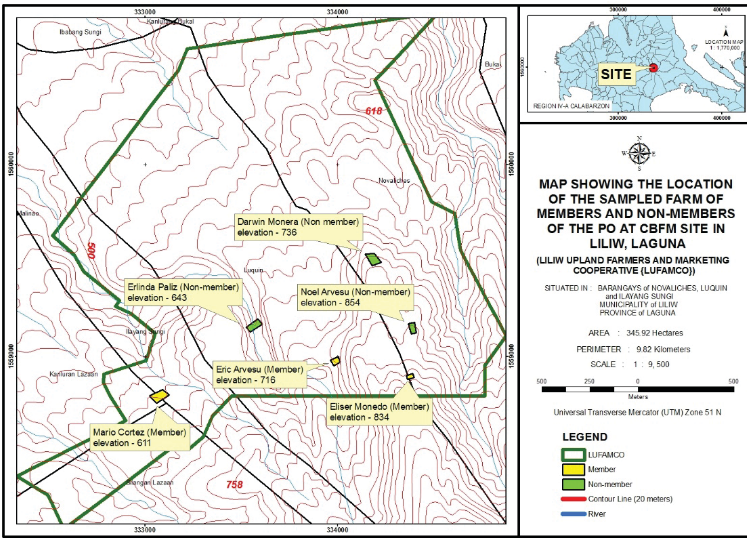

Figure 2. Schematic map showing the location of the sampled farm of members and non- members of the PO at CBFM site in Liliw, Laguna.

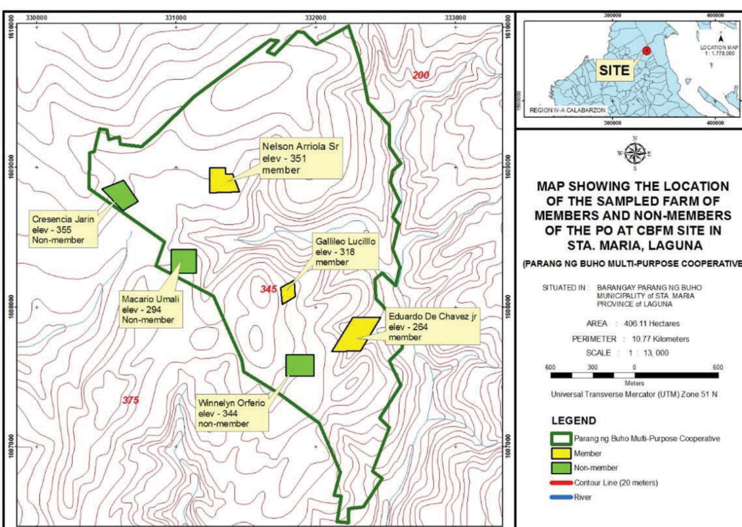

Figure 3. Schematic map showing the location of the sampled farm of members and non- members of the PO at CBFM site in Sta. Maria, Laguna.

General Flora Survey

The researcher used quadrat method to determine species diversity at farm level. Counting the number of tree species and number of individuals under each species in each representative agroforestry system was conducted in 10m x 10m quadrat for each farm. A total of twelve (12) quadrats were established for both CBFM sites. Six (6) quadrats per site were established representing two (2) quadrats per elevation (high, middle and lower elevation) of the study sites. Each elevation was represented by farm of member and non-member consisting of three (3) farms of member and three (3) farms from non-member for each site. Agrobiodiversity analysis for PO member-farmers and non-member farmers was determined using the Shannon's index of diversity (H), Shannon's index of evenness (E) and Simpson's index of dominance (D). The species that are greatest in number were used as the basis for determining dominance. Other information regarding the biophysical environment was gathered through key informant interviews and available secondary data.

Soil Chemical and Physical Properties

The researcher determined the soil physical and chemical properties by collecting soil samples at 4 cardinal directions (North, East, South and West) to a depth of 15 cm for both CBFMA sites. One kilogram of composite soil sample from each CBFMA site was brought to the Analytical Services Laboratory of Soils and Agro-ecosystems Division, Agricultural Systems Cluster, College of Agriculture at University of the Philippines Los Baños for analysis. The soil properties analyzed are soil pH using electrometric method, organic matter (OM) using Walkey-Black method, available Nitrogen using Kjeldahl method, available Phosphorus (P) using Bray method, Exchangeable Potassium (K) using ammonium acetate method, and soil bulk density using core method.

Measurement of Soil Erosion

Modified erosion bar was used by the researcher to measure of soil erosion (Ramirez, 1988 as cited by Visco, 1997). Six (6) erosion plots were installed for both CBFM sites; two (2) on upslope, two (2) on midslope and two (2) on the downslope portion. The erosion plots were installed for representative agroforestry systems of members and non-members of the CBFM based on elevation. A total of twelve (12) erosion plots were installed for both CBFM sites. The erosions were measured using the instrument made of 2.5m long aluminum bar with 10 holes spaced at 15 cm apart through its opposite sides.

The bars were rested on top of GI sheet. Identical metal measuring pins were inserted into each hole facing the ground resting on the soil surface (Figure 4). The level of the soil surface was measured on the metal pins by a measuring stick for every point sampled. Initial data was measured and recorded at the beginning of the research. Succeeding measurements were recorded monthly for six (6) months. The level of the washed soil was computed by determining the difference of the topsoil level of each point in the plot.

Figure 4. The modified erosion bar used in monitoring soil erosion. (Adapted from Ramirez, 1988 as cited by Visco, 1997)

The data was converted into its equivalent weight unit (tons/ha) using the procedures adopted by Visco (1997) as follows:

Volume plot = (depth of soil wash) x (length of plot) x (width of plot)

The volume of the solid particles in the washed soil was converted to its equivalent weight per hectare based on the size distribution of the soil in the experimental plots using the conversion figures formulated Ecosystems Research and Development Bureau (FORI, 1986 as cited by Visco, 1997): (1 cu. m. of sand =1,497 kilograms; 1 cu. m. of silt = 1,046 kilograms; 1 cu. m. of clay = 483 kilograms)

RESULTS AND DISCUSSION

Vegetation Composition of Agroforestry Farm

It was observed that farms in Liliw, Laguna are located in wind-prone areas. The farmers practiced boundary/border-planting type of agrisilvicultural system. Nair (1989) classified this type of agroforestry practice as "shelterbelts and windbreaks, live hedges". The main crops (local agricultural crops) are planted inside the farm bounded by a combination of tall-growing spreading types of forest trees, shrubs and some fruit trees (Figure 5). The trees, forest trees and fruit trees, are planted in the borders while some are within the farmlands. Since most of the farms are located in wind-prone areas, the trees serve as windbreak/ shelterbelts and at the same time serves as sources of fuelwood.

The components are arranged spatially to achieve economic and environmental benefits of the farm. In shelterbelts and wind breaks, live hedges agroforestry practice, the agricultural crops are usually grown on alleys formed by hedgerows of trees in combination with forage, legumes, grasses or trees, particularly fast-growing tree species, or vegetables planted parallel or perpendicular to tree rows as boundary planting. The interaction of trees and agricultural crops is defined as the effect of one component of a system on the performance of another component and/or on the behavior of the overall system (Nair, 1993). The trees improve nutrient use efficiency by recovering nutrients leached in soil layer beyond the reach of shallow-rooted vegetables.

Figure 5. Mixed agricultural crops (vegetables) planted inside the farm of PO member-farmer in Liliw, Laguna. The boundaries are composed of fruit trees mixed with kakawate (*Gliricidia sepium*), coconut, narra (*Pterocarpus indicus*) and mahogany (*Swietenia mahogany*).

However, the researchers observed differences in agroforestry practices between the members and the non-members of the People's Organization (PO). Majority of the members of the PO practiced planting of forest trees and fruit trees along the farm boundary while the farm boundaries of non- members are composed mostly of naturally grown shrubs and grasses like cogon (*Imperata cylindrica*), talong punay (*Datura metel*) and kakawate (*Gliricia sepium)*. The forest trees and fruit trees planted by members of PO are usually part of the assistance from the DENR being a member of the CBFM and the agency's forest rehabilitation program. Non-members of the PO believed that planting of fruit trees and forest trees might serve as hindrance to the growth and development of agricultural crops, which are their main crop.

The PO members planted fruit trees, plantation crops and forest trees that served as shelterbelts and windbreaks for the main crop as well as boundaries to other farms. The boundary also includes some shrubs planted along the boundaries to serve as farm markers. The boundary also includes some palms and bamboos that are beneficial to the farmers. Several farmers planted kakawate (*Gliricidia sepium*) arranged within the farm to serve as live trellis for black pepper (*Piper nigrum*) and to enhance the soil condition within the farm (Figure 6). They also used kakawate (*Gliricidia sepium*) in combination with other grasses for animal nourishment. The crops are usually rain fed. However, members of the PO rely on small water impounding structure built by DENR.

Figure 6. Kakawate (*Gliricidia sepium*) that served as live trellis for climbing crops like tomato, black pepper and bitter gourd at Liliw, Laguna.

Farmers start planting the main crops/agricultural crops at the onset of rainy season. The type of vegetables planted usually depends on the crops planted by majority of the farmers within the CBFM area. Majority of the farmers, whether member or non-member of the PO, practiced planting using cropping calendar. They sell their products, usually vegetables, through wholesale system. The middlemen bought their products prior or after its harvest.

In Sta. Maria, Laguna, the researcher observed that farmers practiced "multi-layer, multistorey tree garden" type of agrisilvicultural systems (Figure 7). The farms are composed of multipurpose trees, fruit trees and common agricultural crops. The main crops (fruit trees) are planted inside the farm in combination with other types of forest trees. The main crops, mostly fruit trees are scattered/ mixed sparse within the farm in combination with agricultural crops. The main crops and agricultural crops are planted in combination with forest trees like mahogany (*Swietenia macrophylla*) and kakawate (*Gliricidia sepium*) and other naturally occurring *Ficus* species. The main crops are usually rain-fed. However, vegetables and other agricultural crops used for family's consumption are watered through pipeline irrigation from the spring. Surpluses from the harvest are sold in the market or through retail store. Several farmers raise farm animals like native chicken and pigs for their consumption and additional income.

Figure 7. Type of agrisilvicultural systems in Sta. Maria, Laguna (multi-layer, multistorey tree garden).

Agrobiodiversity of Agroforestry System

CBFM Site in Liliw, Laguna

There were 39 species found in the farms of PO member-farmers, 16 or 41% of which are woody perennials. The species observed in their farms were cabbage (*Brassica oleracea*), corn (*Zea mays*), spinach (*Basella alba*), gabi (*Colocasia esculenta*), lettuce (*Lactuca sativa*), pechay (*Brassica rapa*), and silantro (*Coriandrum sativum*), to name a few. Several woody plants species and forest trees like bitaog (*Calophyllum inophyllum*) and narra (*Pterocarpus indicus*) were commonly planted within the boundaries.

The diversity index of these farms is 2.58 with evenness index of 0.70. Using the Modified Fernando Biodiversity Scaling System (Fernando, 1998 as cited by Palis, Castillo & Rivera, 2011), these farms are moderately diverse considering the number of species compared to the number of individuals of all the species in the area. The evenness index shows that the farms are not that varied. Based from the index of dominance formula used, the three most dominant species in these farms are cabbage (*Brassica oleracea*) with 0.272, followed by corn (*Zea mays*) with 0.128, and spinach (*Basella alba*) with 0.082. These species were dominant, because the data gathering activity fell during its planting season.

For non-member farmers, all sampled farms had 21 species consisting of mutha (*Cyperus rotundus*), uray (*Amaranthus spinosus*), cogon (*Imperata cylindrica*), talong punay (*Datura metel*), and kakawate (*Gliricia sepium)*, among others. Eleven (11) or 52% of which are perennials. Cabbage (*Brassica oleracea*) and gabi (*Colocasia esculantum*) were the planted agricultural crops. Both PO member-farmers and non-member farmers usually planted kakawate (*Gliricia sepium*) to serve as trellis.

The diversity and evenness indices for the non-members' farms were 1.98 and 0.65, respectively. The non- members' farms have low biodiversity considering the total number of individuals in the area. Thus, the farms were less varied as shown by the evenness value. The three most dominant species were mutha (*Cyperus rotundus*) with dominance index value of 0.356, uray (*Amaranthus spinosus*) with 0.201, and cogon (*Imperata cylindrica*) with 0.126. These species dominated the said farms, because these areas were not properly tilled by the farmers.

It may also be observed from the results that the farms of PO members were more diverse (diversity index was 2.58) than the non-members (diversity index was 1.98). This is because, aside from providing them with forest tree planting materials, and seeds of agricultural crops, PO member-farmers practiced intercropping of fruit trees and forest trees as a result of trainings conducted by the abovementioned government agencies intended for the PO members.

CBFM Site in Sta. Maria, Laguna

Thirty-two (32) species were observed in the farms of PO member-farmers in Sta. Maria, Laguna. Twenty (20) or 62.5% of the species are perennials. Some of the species observed in PO member-farmers included cogon (*Imperata cylindrica*), lanzones (*Lansium domesticum*), cassava (*Manihot esculenta*), hauili (*Ficus septica*), sweet potato (*Ipomea batatas*), murado (*Pseuderanthemum atropurpureum*), and rambutan (*Nephelium lappaceum*). Murado (*Pseuderanthemum atropurpureum*) was used by farmers as boundary markers or as markers for newly planted tree crops, because of its violet color and could be easily seen in the farms.

The indices of diversity and evenness of members' farms in Sta. Maria, Laguna were 2.72 and 0.78, respectively. The farms are considered moderately diverse. The evenness value shows that the farms are less varied, taking into account the total number of individuals in the area. This means that some species have so much number of individuals compared to the other species.

In terms of dominance, the three most dominant species in these farms were cogon (*Imperata cylindrica*) with 0.310 index, sili-silihan (*Ruellia tuberosa)* with 0.074, and lanzones (*Lansium domesticum*) with 0.068. Cogon was the dominant species, because it thrives on vacant spaces in the farm. Lanzones was the third most dominant species, as mentioned, member-farmers preferred planting of perennial crops.

A total of 28 species were gathered from the sampled agroforestry farms of non- members in Sta. Maria, Laguna. Twenty (20) or 71.4% of which are perrenials. The species found in the said farms were wedelia (*Wedelia triloba*), an exotic invasive species, corn (*Zea mays*), edible fern (*Diplazium esculentum*), big leaf mahogany (*Swietenia macrophylla*), murado (*Pseuderanthemum atropurpureum*), coconut (*Cocos nucifera*), coffee (*Coffea arabica*), and cogon (*Imperata cylindrica*), among others.

The sampled agroforestry farms of the non-members had diversity and evenness indices of 1.86 and 0.56, respectively. The diversity index was considered low with again less variation among species, considering the differences in the number of individuals per species.

On the other hand, the three most dominant species in these farms were wedelia (*Wedelia triloba*) with 0.585 index, corn (*Zea mays*) with 0.068, and big leaf mahogany (*Swietenia macrophylla*) with 0.057. Wedelia was observed in all non-member farms. Accordingly, this species was the major competitor for farmer's valuable crops. It usually occurred if the area has been abandoned for a long period of time. Other species like corn (*Zea mays*), edible fern (*Diplazium esculentum*), and big leaf mahogany (*Swietenia macrophylla*) were planted in groups in the portion allotted for vegetable crops. Other farmers planted big leaf mahogany (*Swietenia macrophylla*) in boundaries or intercropped with other fruit-bearing trees to be harvested after 10 to 15 years.

It is observed that farms belonged to PO member-farmers in Sta. Maria, Laguna were more diverse (diversity index of 2.78) compared with non-member farmers (diversity index of 1.86). The same reason could be attributed to the assistance from DENR, DA and LGUs to PO member-farmers. On the other hand, comparing the two sites, CBFM area in Liliw, Laguna is more diverse than Sta. Maria, Laguna, which could be due to different species (mostly vegetable crops) planted in Liliw, Laguna. However, more perennial (forest trees and fruit trees) species were observed in Sta. Maria, Laguna. Another worth noting is that a community (in this case, the sampled agroforestry farms) that contains a few individuals of many species is said to have a higher diversity than a community having the same number or greater number of individuals with most of them belonging to a few species (Smith & Smith, 2000). Thus, it is important in a community to have higher number of species as well as even distribution of individuals per species to be considered diverse.

Soil Physical Properties

Soil Bulk Density

In Liliw, Laguna, the initial and final average soil bulk density is 0.92 gm/cc and 1.07 gm/cc, respectively. An increase in bulk density can be attributed to the compaction of soil after planting. High bulk density is an indicator of low soil porosity and soil compaction. Compaction increases bulk density and reduces crop yields and vegetative cover available to protect soil from erosion. As described earlier, the soil type in Liliw, Laguna is moderate-to-deep well-drained soils with a moderate to rapid infiltration rate. The farmers practiced conventional tillage prior to planting. Conventional tillage influences soil porosity, bulk density, penetration resistance and moisture content (Khurshid et al., 2006 as cited by Appah, 2012). Annual disturbance and pulverization of soil through ploughing and harrowing produce a finer and loose soil structure compared to conservation or no-tillage methods which leave soil intact (Rashidi et al., 2008 as cited by Appah, 2012).

In Sta. Maria, Laguna, the initial and final average of bulk density of soil is 0.91 gm/cc and 1.21 gm/cc. A slight difference in bulk density for both sites can be attributed to soil type and farming practices. The soil type is fine loamy somewhat poorly drained type and fine to very fine somewhat poorly to poorly drained type. Farmers in Sta. Maria, Laguna practiced no-tillage. No-tillage reduces water loss from soil and improves soil moisture regimes than plough and harrow (Azooz et al., 1996 as cited by Appah, 2012) because more surface areas of soil are exposed to sunshine and stream of wind in conventional tillage. Moreover, no-tillage maintains surface residues, minimizes soil disturbance, encourages build-up of organic material, preserves the soil structure, and conserves soil water.

The results of bulk density analysis for Liliw, Laguna (sandy silt clay) and Sta. Maria, Laguna (sandy clay loams) are still considered ideal for plant growth under the standards set by USDA for general relationship of soil bulk density to root growth based on soil texture. Moreover, the statistical test of difference using paired sample t-test shows that there are no significant differences between the average bulk density of soil prior to the first observation and the final observation of soil regardless of the site and membership of sampled farms. This could be due to continuous cultivation prior to planting and short duration of the study.

Soil Erosion Rate

The depth of soil loss and erosion rate of PO member farmers and non-members farmers in Liliw, Laguna were 0.52 cm and 0.04 cm, respectively. This non-significant effect of agroforestry systems practices on soil erosion in Liliw, Laguna could be attributed to farmers' vegetative planting practices along the boundaries of their farms. The initial data contained the information prior to the planting of agroforestry crops in their farms, while the final data indicated the information six months after the initial reading was conducted.

In Sta. Maria, Laguna, the average depth of soil loss for PO member farmers and non- member farmers were 0.87 cm and 0.58 cm, respectively. The non-significant effect observed in Sta. Maria, Laguna could be attributed to the ground cover that was observed on the farms of non-member farmers. The initial and final data were gathered to determine the changes after six months (duration of the study), since their crops were mostly perennials.

The sheet erosion data recorded in the study were converted in their equivalent weight per hectare using mathematical computations. The average soil loss in Liliw, Laguna (1.37 tons per hectare) was higher than in Sta. Maria, Laguna (0.83 tons per hectare). This was due to the significant number of perennial trees and ground cover in Sta. Maria, Laguna. The findings also agreed with the results of Paningbatan (1995) as cited by Visco (1997) that large reduction in soil loss was affected by increasing surface contact cover. Surface litter cover from the perennials as well as its canopy helped control soil erosion. However, soil erosion for both sites was still considered tolerable as suggested by Weischmeier and Smith (1978) as cited by Visco (1997) where the tolerable range is between 2 to 11.2 tons/has/yr. Thus, the results for both sites could be classified as low since the soil erosion was less than 2 tons/has/yr.

Soil Chemical Properties

The results of soil chemical analysis for CBFM site in Liliw, Laguna revealed that the soil is high in organic matter having 5.7%, moderately acidic (pH = 5.6), contains medium amount of total N (0.32%), high amount of available P (38.98 P ppm), and high amount of exchangeable K (0.91 me 100 g-1 of soil).

Traditionally, the farmers of Liliw, Laguna use chicken manure as fertilizer for their agricultural crops. The practice has huge impact on soil chemical property of the farm. Farmers used the chicken manure as they observed it to be more effective than other animal waste. The same observation was found by Warman, 1986; Duncan, 2005 as cited by Dikinya and Mufwanzala, 2010, due to high concentration of macronutrients particularly P and K in chicken manure. The results of the analysis strengthen the observation of Dikinya and Mufwanzala (2010) regarding the effect of using chicken manure in enhancing soil fertility and productivity. Accordingly, there was a significant increase in available P with increasing application rate of chicken manure. This is due to the increase in available P in the chicken manure in addition to the mineralogical composition of the parent material (Brady and Weil 1996; Duncan 2005; Agbede et al., 2008 as cited by Dikinya and Mufwanzala, 2010). Further, it has been observed that with increasing application rate of chicken manure, available P and K tend to increase while N appears to be lower. In the case of Liliw, Laguna, that N deficiency could also be a result of continuous planting and harvest of vegetable thus farmers are planting nitrogen-fixing plants like kakawate (*Gliricidia sepium*) and other leguminous plants to improve the soil condition. *Gliricidia sepium* and *Erythrina* spp., are used mainly for their 'service functions', especially biological

N_2-fixation, production of nutrient-rich litter and shade (Schroth, Lehmann, Rodrigues, Barros & Macêdo, 2001). With regards to soil acidity, Horswill et al., 2007 as cited by Dikinya and Mufwanzala,2010, reported that the acidity of the chicken manure would decrease by 0.2 - 0.4 points if the manure is used for longer periods (8 - 10 years). Moreover, Wong et al., 1983 as cited by Dikinya and Mufwanzala, 2010 found that the acidity due to chicken manure addition severely affected the root growth and seed germination of Chinese cabbage (*Brassica parachinensis*).

The results of soil chemical analysis for CBFM sites in Sta. Maria, Laguna revealed that the soil has high (4.3-6.0 %) organic matter content (4.56%). The soil is very acidic (4.89) as it is below the critical level range for pH is from 5.5-6.5. The percentage of N content (0.24) is considered medium (<5.0). The P ppm of soil (4.13 P ppm) is low (<10) and the K me/100g of soil (0.65) is high (0.60 – 1.20).

As mentioned by Jensen, 2010, the low P ppm content of the soil is related to its acidity. Accordingly, at acidic pH values, phosphate ions react with aluminum (Al) and iron (Fe) to again form less soluble compounds. Most of the other nutrients (micronutrients especially) tend to be less available when soil pH is above 7.5, and in fact are optimally available at a slightly acidic pH, e.g. 6.5 to 6.8. However, the acidity of the soil can be attributed to the present condition of the farm. Since all of the sampled farms are considered to be at its growing stage (newly established farms), the increased accumulation of aboveground biomass and associated cation uptake by the tree component of agroforestry systems is possibly one of the causes for decreased pH in these soils (Tornquist, Hons, Feagley & Haggar, 1999). Juo and Manu, 1996 as cited by Tornquist et. al., 1999 observed that regenerating vegetation will frequently decrease pH in soils with low nutrient stocks. This phenomenon might be related to several mechanisms that release H ions, such as cation uptake by biomass, decomposition of organic matter to organic acids and CO_2, root respiration and nitrification (Tornquist, Hons, Feagley & Haggar, 1999). These processes are counter- balanced to some extent by several sinks for H± the weathering of soil minerals, anion uptake by biomass and release of cations from soil organic matter (Binkley and Richter, 1987 as cited by Tornquist et. al., 1999). Agroforestry systems showed significantly lower pH at the 10±25 cm depth, probably because tree root abundance is higher at this depth (Bowden, 1985 as cited by Tornquist et. al., 1999).

Statistical Test of Difference Using Paired Sample T-test

Average of the results of the initial and final soil chemical analyses for PO member farmers and non-member farmers were used for the statistical test of difference using paired sample t-test (Table 2).

Table 2. Results of initial and final soil chemical analysis on CBFM areas.

Site / membership	OM %		Soil pH		Nitrogen %		P ppm (Bray)		K me/ 100g soil	
	Initial	***Final***	***Initial***	***Final***	***Initial***	***Final***	***Initial***	***Final***	***Initial***	***Final***
Liliw member	5.55	5.70	5.83	5.30	0.29	0.33	42.63	12.10	0.88	0.77
Liliw non-member	5.65	5.89	5.83	5.47	0.30	0.37	10.43	6.80	0.95	1.03
Sta Maria member	4.81	4.72	5.03	4.77	0.26	0.22	6.83	2.03	0.71	0.42
Sta. Maria non-member	4.09	4.63	5.00	4.80	0.22	0.24	4.83	2.83	0.93	0.55

As for the organic matter content, there are no significant differences between the average organic matter of soil prior to the first observation and the final observation of soil regardless of the site and membership of sample farms.

Table 3 shows significant differences on the average soil pH during the initial and final measurement were observed on the sampled farms of CBFM members from Liliw. Average value of 5.83 pH was observed on the sample farms from CBFM members during the initial collection, which decreased to 5.3 pH during the final soil collection. Likewise, the average differences on the soil pH during the initial and final measurement of soil collected from sample farms of non-members from Liliw were considered highly significant at 99% level of confidence. There were no significant differences on the soil pH on the sample farms of CBFM members in Sta. Maria before and after the first and final soil collection.

Table 3. Test of difference on soil pH (initial measurement – final measurement).

SITE /MEMBERSHIP	AVERAGE DIFF.	STD. DEV.	t-value	df	p-value
Liliw (member)	0.53	±0.21	4.42	2	0.40*
Liliw (non-member)	-0.13	±0.06	11.00	2	0.008**
Sta. Maria (member)	0.27	±0.32	1.44	2	0.29 NS

** - Highly significant at 99% level of confidence,
* - significant at 95% level of confidence
NS - Not significant
*standard error of difference for Sta Maria (non-members) is 0.

There are no significant differences in total N content, available P and exchangeable K of soil prior to the first and final observation regardless of the site and membership of sample farms for both sites.

CONCLUSIONS

Farmers' desire for a specific design of agroforestry for both farmers from Liliw and Sta. Maria, Laguna are influenced by adaptability, availability of resources, peer influence and ability to provide immediate solutions. PO member-farmers including several non-member farmers from Liliw, Laguna practiced shelterbelts and windbreaks, live hedges agroforestry system while PO member-farmers and non-member farmers from Sta. Maria, Laguna involved in practicing multi-layer, multistorey tree garden. Each agroforestry system provides different benefits that indeed beneficial to farmers.

Results of different analyses involved show that agroforestry systems vary in terms of soil erosion, soil productivity, and agrobiodiversity. The variation is greatly influenced by agroforestry systems components and their interactions.

All the respondents tend to depend on other sources of income to sustain their monthly expenses. For PO member-farmers, they seek assistance from the government to provide them additional trainings and assistance necessary to improve their conditions. PO non-member farmers do not depend on the government since they are not fully aware or interested with the program.

Regardless of the kind of agroforestry system practiced in the CBFM sites, it has been observed that agroforestry is indeed beneficial for both study sites. However, appropriate assistance from the government is still necessary to convince the PO member-farmers as well as the non-member farmers that indeed the government is serious in helping them improve their present condition and empower them to be an important asset in safeguarding our upland resources.

RECOMMENDATIONS

Community-Based Forest Management Agreement (CBFMA), as a government's tool to conserve the upland resources and combat poverty of the people living in the uplands, has different impacts on the upland community. CBFMA encourages farmers to practice agroforestry due to its environmental services and it is the most appropriate alternative farming system that will address the problem. However, based on the results of this study, the following are hereby recommended and need to be addressed:

Diversification of perennials and cash crops through intercropping and inclusion of local breeds of poultry and livestock results to increase the benefits obtained from the agroforestry system.

Enhancement of socio-economic resiliency by providing farmers with, sufficient training and capacity building, access to market, appropriate affordable machinery and post-harvest technologies, access to capital and empowerment of cooperative, and participation of both men and women in the planning and implementation of the projects for sustainability.

Enhancement of the implementation of Community-Based Forest Management Agreement by addressing the conflicting land-use and participation of community in choice of species and other program activities.

Thorough and in-depth research project should be conducted by DENR to support the findings.

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