VALUING ECOSYSTEM SERVICES, BIODIVERSITY AND THEIR CONTRIBUTION TO FARMER'S LIVELIHOOD WITH POTENTIAL FOR FUTURE BENEFIT SHEARING MECHANISM OF FORESTGARDEN FARMING SYSTEMS OF THREE DIFFERENT AGRO-ECOLOGICAL ZONES IN SRI LANKA.

Pushpakumara K.G.J[1]*, Pulasthi patirana[1] and A.A.S.H.Athukorala[1]

[1]Green technology forum, No 200, Mata Road, Kamburupitiya, Sri Lanka

Email:greentef@gmail.com

KEY WORDS: Forest garden, total ecosystem services, payment for ecosystem services, Spatial mapping, Image classification.

ABSTRACT

Forestgarden (FG) farming is one of dominant upland farming system in Sri Lanka which has been coevolving over the thousands of years as human-ecological system. Analogforestry(AF) is the silvicultural method that develop base on forest garden farming system and principle of system ecology. Forest Garden Products (FGP) certificate is the accredited organic certification system that developed based on IFOAM organic standards fair trade standards. Famer communities subjected to the study, produce various forestgarden products under FGP standards. Ecosystem Service(ES) and livelihoods are the important components of human-ecological system. These two components show strong relationship. This study was aim to analyze these components individually as well their relationship. Spatially mapping also other key object in this study. Analysis of potential to initiate payment for ecosystem service(PES) programme ,ES related policy aspects and AF principle based silvicultural context of forestgardnes also were important objectives in the study. Etanwala, Owilla ans Kadanbewa were sample villages relevant to agro-ecological zone IM1b, WM3b and IL3 respectively. Total ecosystem approach was followed for quantification of ES and field experimental approach in contrast with earlier value transfer method were adopted assess monitory values of ES. Biodiversity quadrant and biodiversity transect were practiced for the biodiversity survey. Evaluation of analog forestry principle based silvicultural background of FG and assessment of carbon stock were include as biophysical component of the study . Socio economic components in the study was consist with structure questionnaire survey, formal discussions and structured interview.Spatial mapping of ecosystem service was done using with Satellite images taken with Landsat TM sensor in 2003 and images were classified with ERDAS imagine 2010 software.Sequestrated carbon was map up to agro-ecological zone level. Total economic value of IM1b, WM3b and IL3were US $ billion 473162.4 $ha^{-1}yr^{-1}$, US $ billion 467164ha $^{-1}yr^{-1}$and US $ billion 503835 ha $^{-1}yr^{-1}$respectively.Heist ES value among set of ES was tourism service (460299ha $^{-1}yr^{-1}$).Margalef's index values related species richness of floral component in Owilla, Etanwala,Kadanbewa were 9.892, 10.408 and 8.697 respectively, Simpson diversity index were 7.317, 3.038 and 6.291 . Shannon-Wiener index values Owilla, Etanwala,Kadanbewa were 2.682, 2.087and 2.420 respectively.Faunal component related index values were Margalef's index, 11.318,11.97, 12.882, Simpson index 49.192 , 49.115,3.785 Shannon-Wiener index 3.948, 4.049, 4.178. Physiognomic formulas of forestgardens in Etanwala was V7pV6r,V5r,V4p,V3b;R3p,R2r;B6b;P6r,P5r;L1-6 p;G1r. Owilla -V8bV7p,V6p,V5p,V4r,V3r,V2r;G1p;L1-7 r;C4p;R5r,R4r and Kadenbewa- V7r,V6p,V5p,V4r,V3r;G1p;L1-6 p;C4b;P5r;P67,P5r,p4r. 60% of household were forest garden as sole income source. Income was increased 93 % house hold through FG farming. Forest garden was significantly enhance the wellbeing of FG farmers(P value 0.000). Effective payment policy option was only the individual payment. Mid and high conditionality was significantly accepted by the farmers(p value>0.01). 81% of consumers were willing to pay 11%-20% additionally for FG products on behalf of ES.

1.INTRODUCTION

Forest garden is the malty- story production system comprising several perennial food cropsfruits spice crops and timber crops has continuously provide high level of nutritional diversity and diet diversity to household while medicinal species and tree species provide substantial additional income . Forest garden is important for biodiversity conservation. It is providing habitat for various life form and there is high faunal diversity than natural forest. Forest garden act as bio-link for and it is help to move the gene flowacross natural forest ecosystem. This is human engineered or manmade ecosystem with rich pool of various ecosystem services. Forest garden is important model for sustainable

land use as well as it is well stable and resilience production system in front of global environmental dynamics. This is model of sustainable development and it is harmonize human wellbeing versus ecological wellbeing.

Analog forestry is silviculture technical concept developed based on fundamental ecological and economical features that inherent with forest garden ecosystem and principles of system science as well.Simple meaning of Analog Forestry (AF) is a system which seeks to establish analog ecosystems with architectural structures and ecological functions similar to the original climax or sub climax vegetation. It also seeks to strengthen rural communities, socially as much as AF can help local people to build their sustainable livelihoods. AF is about increasing the resilience and biodiversity of a landscape by making use of natural ecological succession processes (natural succession from barren land/grassland to climax forest) as a model for agricultural and forestry production.

Livelihoods and ES are highly interdependent two factors in human-ecological system. Sustainable livelihoods may sustenance or restore the ES while some time livelihoods types damage or deplete the ES. Forest garden faming is the greenest livelihoods types that make positive impact on nature.There is strong relationship between livelihoods and ecosystem services and it was major reason for discuss this two tropics together in development sector.

Land degradation pressures such as soil erosion and deforestation have emerged with present conventional agricultural practices is an important issue in the development debate in Sri Lanka, affecting directly the productivity of agriculture as well as impacting on water resource availability, the availability of key ecosystems services.

In other hand sustainable agriculture practices such as Analog forestry of forest garden farming can significantly enhance the ecosystem services provided by agriculture. Forest garden farmers routinely manage for greater provisioning services by using inputs and practices to increase yields, but management practices can also enhance other ecosystem services, such as pollination, biological pest control, soil fertility and structure, water regulation, and support for biodiversity.

2.STUDY AREA

tAtanwala, Owilla and Kadanbewa were Three villages inthree agro-ecological of two district were selected for this study

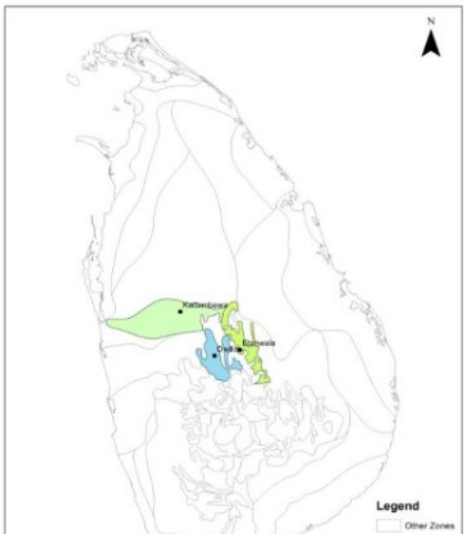


Figure 1.Map of three agrological zones that subjected to study.

Etanwala village was represented mid country intermediate zone(IM1) ant it is belong to Laggala-Pallegama divisional secretariat area of Matale district. This village situated boundary of Knuckles world heritage site. Paddy farming is main means of livelihoods. Owilla was the other in Matale district and it is represented mid country intermediate zone(IM3) agro-ecological zone and it is belong to Ukuwela divisional secretariat also.Typical Kandiyan home garden or forest gardens are available in these villages. Spice and other minor export crops such as cocoa are the main commercial agricultural products.

Kadanbewa was representative village for the agro-ecological zone low country intermediate zone(IL3). This village is situated in Daladagma divisional secretariat area near to Yapahuwa historical kingdom in Kurunegala district. This area is clearly belong to low country dry zone. Coconut based forest garden are main type of farming system available in the area

3. METHODOLOGY AND MATERIALS

3.1 Field Experiment And Evaluation Of Biophysical Variables

Biodiversity quadrant technique was applied for this floral biodiversity survey . In that case, 15 numberof 10m x 10m quadrant was placed as 1quadrant per home garden. All the life form including trees, shrubs, herbaceous plant were recorded in the each quadrant.The faunal biodiversity of forest garden were conducted during the month of December 2014 – January 2105. All faunal group were selected were primarily surveyed using the visual encounter survey method (VES). The specific sampling methods were adopted to record these faunal groups

Transect walk method was appliedd for survey birds, mammals, aeptiles, amphibians, land snail ,butterflies, Terestrial artropods spicies were sampled using with Sweep net sampling techniques.

3.2 Analysis Of Biodiversity Indices

Biodiversity of floral and faunal component in three locations were calculated using excel base software. Margalef's index was used to analyze species richness and diversity was analyzed using with Shannon Weiner index and Simpson's index.
Speciesrichness were calculated as SR=S-1/In(N) where SR= Margalef(1958) index of species richness S=number of species and, N= Total number of individuals.

Shannon Weiner index
The idea behind this index is that the diversity of a community is similar to theamount of information in a code or message. It is calculated in the following way:
$H' = -\sum p_i \ln p_i$
Where p*i* is the proportion of individuals found in species I.. For a well-sampledwhere*i* is the number of individuals in species i and N is the total number of individuals in the community.
Simpson's index
$D = \sum p_2^i$
Evenness and dominance are measures with this index .Where again p^i is the proportion of individuals found in species i. For a finite community, D is a measure of dominance

3.4 Carbon Stock Assessment

15number of quadrants 10m x 10m size sampling were practice in 15 production units or home garden in each three locations and totally 45 home garden were covered for carbon stock assessments. All trees with diameter at barest height higher than 5 cm were measured using measuring tape and height was measured with clinometers techniques. Specific wood density data was taken from international wood density database of World agro forestry center. Estimation of biomass content was calculated using Winrock (from Brown, Gillespie and Lugo, 1989) equation.

$Y = \exp\{-2.4090 + 0.9522 \times \ln[(DBH2)HS]\}$

Where: exp{…}=" Raised to the power of " In= "natural log ", Y= Biomass per tree in kg, DBH= Diameter at barest height(cm), H= Height (m), S= Specific wood density, Biomass of the three locations were calculated using with excel based software

3.5. Socioeconomic Study

Socio economic study was include structured questionnaire survey, formal discussions and structured interview Questionnaire survey was carried out to survey three groups of community including organic and conventional farmers and consumers of organic products.

Household surveys focused on these two groups were consisted of open- and closed-ended questions. Sample sizes was 30 in each three locations. Data were collected on the following factors such as household demographics (age, gender, occupation, etc.), household livelihoods (income sources, savings, debt, agricultural products, education, and support networks); (3) farmer's perceptions of biodiversity conservation etc.

Consumer survey focus to measure willingness to accept or purchase ecosystem services of forest garden livelihoods. Focus groups and semi-structured interviews were conducted to collect key information. Semi-structured interviews conducted with selected forest garden farmers and questioned on Special cultural and management practices they use suggestion for further development, identify and estimate the quantity of ecosystem service, non monitory exchange or benefit shearing with other members.

3.6 Choice Experiment

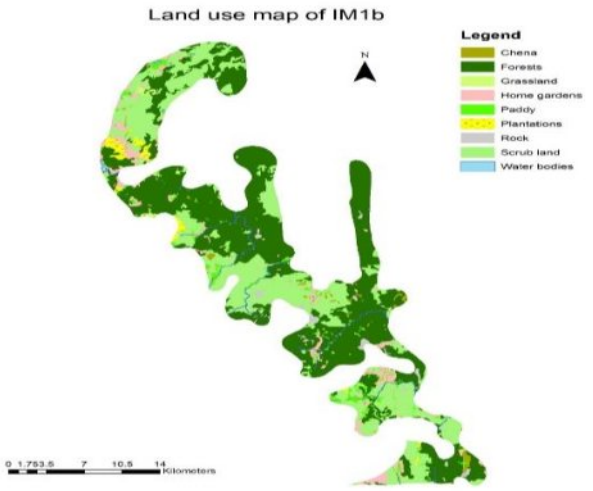
Choice experiment was used to assess preference of forest garden farmers and conventional farmers on different choices or scenario in PES programme.There were include package of attributes relevant with environmental quality of forest garden and payment levels. Overall utility derived from a contract under different payment level and conditionality express as utility function and it was computed with multinomial logit model(Boxall and Adamowicz, 2002).

$$\pi_1(\rho_h) = \sum_{s=1}^{S} \left[\frac{e^{\mu_s A_s X_l}}{\sum_{s \in S} e^{\mu_s A_s X_l}} \right] \left[\frac{e^{\mu_s B_s X_h}}{\sum_{s \in S} e^{\mu_s B_s Z_h}} \right]$$

Where is the h^* PES program scenario, μ is scale of parameter, $B$is a vector of marginal utilities for each program attribute Z_h, B_s and μ_s are segment specific utility and scale parameter respectively ,$A_s$is a coefficient vector specific to segment sX_l Socio-economic determinants of individual membership(i,s). General concepts of conditionality, payment type and opportunity cost were adapted to tangible policy design elements, and the options were refined to meaningful levels based on extensive pretesting in the forest garden.

3.7 Economic Valuing And Spatial Mapping Of Ecosystem

A satellite images of three agro ecological zones belong to study areas were area which has been taken by Landsat TM sensor in 2003 was used for the study. Image was subjected to geometric correction using correct ground control points of an already geo corrected topography map.Then an unsupervised classification was done for these images using "ERDAS imagine 2010" remote sensing software.



KCA was classified into five vegetation categories based on the level of reflectance which represent the biomass variation within the forest. Different vegetation categories within these three agroecological zones were identified using different color regions (Figure 2,3 and 4).Sampling plots from each color category of the image was selected using proportional random sampling technique. 90 sampling plots were selected. Exact geographical coordinates of those sampling plots was identified. Since no algometric relationships was developed for the Sri Lankan context ES measurements were extrapolated up sample plot scale to hectare scale and subsequently to agro ecological zone level.

Figure 2:Land use map of IM1bagro ecological zone

4. RESULTS

4.1 Land Use Context

4.1.1 Agro Ecological Zone IM1b

Etanwala was reprented this agroecological zone IM1bl Zone. Total lands extend of the IM1b Agro ecological zone is 57619.32Ha. Within that, 3619.6 Ha (6.3%) is covered with home gardens(table1).

4.1.2 Agro Ecological Zone WM3b

Total land extend of the WM3b Agro ecological zone is 63043.83Ha. Within that, 26000.2 Ha is covered with forestgardens. (table6and figure6).

Location	Mean size of a forestgarden(Acre)	StandardsDeviation
Etanwala	0.764	0.763
Owilla	3.16	4.97
Kadanbewa	1.418	1.397

Table 1. Mean land size of forestgarden in three study areas.

4.1.3 Agro Ecological Zone WM3b

Total land extent of the IL3 Agro ecological zone is 165710.51Ha. 36% of total land area is cover by forestgarden.

Mean size of the forest garden in the Kadanbewa is 1.418 acres and it is largest forest garden among three location.

Landuse type	Area(Ha)		
	IM1b	WM3b	IL3
Rocks	782.83		
Forestardens	3619.60	26000.20	50731.00
Plantations	792.68	19760.43	50075.29
Paddy	1816.54	7051.12	36682.70
Water Bodies			9362.04
Scrub Lands	19362.80	5760.84	9051.02
Others	826.47	1170.61	5035.19
Forests	30418.40	3300.63	4773.27
Total	**57619.32**	**63043.83**	**165710.51**

Table 2.Distribution of major land use types of IL3 agro ecological zone

Figure 2 shows the distribution of FG in WM3b and table 1 and figure 3 shows the major land use types

Mean size of the forest garden in the area is show in figure It is show high deviation.

4.4.Structural Complexity Of Forest Garden

structural complxcity describie verticly and horizontally using with profile viewe and Physiognomic formula of forestgarden.

Physiognomic formula is describe different floral life forms and there abundance in particular vegetation using various symbols. Etanwala site has four category of woody plant it is reprinting in different canopy strata Two categories of herbaceous plant and this category mainly represent by banana. Owilla forestgarden clearly differ with It is significantly different with Etanwala site.

Location	Physiognomic formula
Etanwala	V7pV6r,V5r,V4p,V3b;R3p,R2r;B6b;P6r,P5r;L7p,L6p;G1r
Owilla	V8bV7p,V6p,V5p,V4r,V3r,V2r;G1p;L7r,L6r;C4p;R5r,R4r
Kadanbewa	V7r,V6p,V5p,V4r,V3r;G1p;L6r,L5p;C4b;P5r;P67,P5r,p4r

Table 3.Physiognomic formula derived for forestgarden of three locations

It is contain seven different types of woody plants types and it is represent different canopy strata of forest system. Five category of woody plant available in Kandanbewa forest garden system. Main types Climber in the farming system are beetle, Diacoria. etc. Grasses can be seen as dominant ground cover.

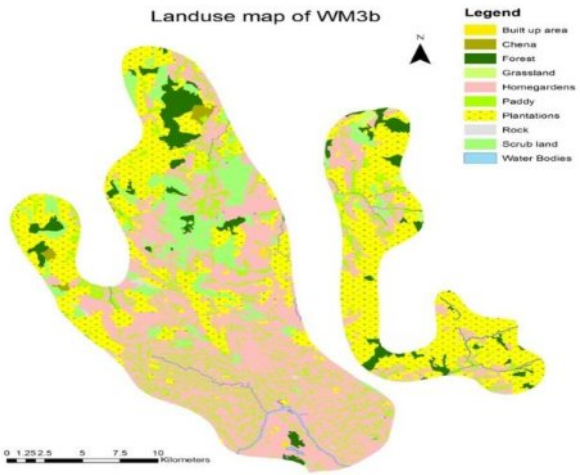


Figure 3. Land use map of WM3b agro ecological zone.

4.5 Agro Biodiversity In Forest Garden

Any scientific study on the biodiversity of Sri Lanka is very important, research outcome of such research are support to Incorporating of biodiversity and ecosystem service values in nationalprogramme on conservation and restoration of biodiversity ecosystem services. National biodiversity action plane is one of the main requirement of strategic Plan for Biodiversity 2011-2020, and the corresponding Aichi biodiversity targets 1 and 2.

4.5.1. Floral Bio Diversity And Species Richness

A total of species101, 84 and 86 trees were identified forest garden in Owilla,Etanwala and Kedanbewa.. Treespecies richness and abundance were compared in the study.

4.5.2.Faunal Biodiversity

Diversity and species richness of faunal component were study. Howe ever species richness data were limit to taken under difficult weather condition in sampling period.

According to the species categories, heist number of birds and reptiles, mammals recorded in Kadanbewa, Highest number of butterfly was recoded in Etanwala

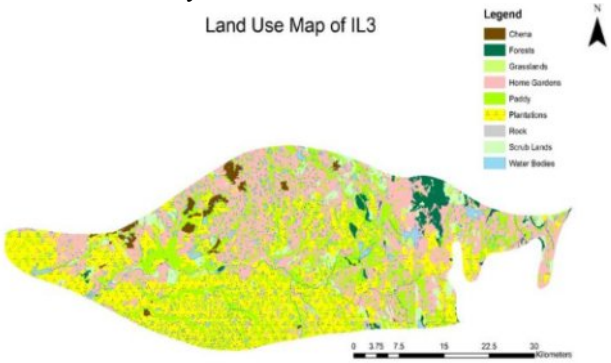


Figure 4: Land use map of IL3 agro ecological zone.

Richness of biodiversity not compare because of these three location is highlydiverse agro ecosystems. This result represents richness of biodiversity itself in particular location.

4.6 Bio Mass And Carbon Stock

Mean Carbon stock of the forestgardens in Owilla is 116.02tC/Ha. It shows a wide ranges from 17.55 to 363.15tC/Ha.Mean Carbon stock of the home gardens in Etanwala is 155.19tC/Ha. It shows a wide ranges from 7.33 to 607.67tC/Ha.. Mean Carbon stock of the home gardens in Etanwala is 68.16tC/Ha. It ranges from 26.15 to 126.62tC/Ha.

Carbon of stock is mainly varies depend upon factors such as biomass volume, species specific wood density.

Carbon sequestration value in each three site summarized below tables 9

(a) (b) (C)

Figure 5. Profile views of forest garden of (a). Atanwala, (b), Owilla, (C), Kadanbewa

	Owilla	**Etanwala**	**Kadanbewa**
Total number of species	101	84	86
Total number of individuals	24556	2906	13959
Margalef'sidex	9.892	10.408	8.697
Simpson index (1/D)	7.317	3.038	6.291
Shannon-Wiener index (H')	2.682	2.087	2.420
Abundance of dominant floral species	*Piper nigrum* (29%), *Coffeaarabica* (19%),*Gliricidiasepium* (17%),*Syzygiumaromaticum*(4%)	*Persea Americana* (14%) *Anonacherimolia*(2%) Canna indica (3%),*Erythrina variegate*(2%), *Gliricidiasepum*(2%) , *Walsura trifoliate* (2%),	*Cocosnucicifera*(34.63%) , *Mussababiliciana* (9%),*Gliricidiasepium*(3%),*Mangiferaindica*(1%),*Anacardiumoccidentale*(2%),

Table 4. Diversity indices and abundance of floral species in three study locations.

	Owilla	Etanwala	Kadanbewa
Total number of species	66	75	83
Total number of individuals	312	495	599
Margalef'sidex	11,318	11.97	12,882
Simpson index (1/D)	49.192	49.115	3.785
Shannon-Wiener index (H')	3.948	4.049	4.178

Table 5.Diversity indices of faunal biodiversity of three study locations.

4.7 Economic Of Ecosystem Services

Total economic value of ES in three different locations were vary. The economic values of ES in Etanwala, Owill and Kadanbewawere US $473162,US $467164,US 468054respectively(table13).
Economic values of ES that derived with ES values take through field experiment and earlier value transfer method use quantify the economic vales of ES extrapolated to agro ecological zone level Using with the GIS base maps.

Total carbon stock of total forest garden cover in agro ecological zoneWM3b, IM1band IL3 will beGiga tons 7.31,0.56 , 3.46 respectively

4.8.Situation Of Livelihood Across The Study Areas

Situation of the livelihoods is highly depend on the ecological and socio economic factors in particular area. There were high specificity of the of the three study location. Therefore, most suitable way was individuallyanalysis instead of comparison of these three locations. Profile of situation livelihood situation mentioned in table 7.

Species category	Owilla	Etanwala	Kadanbewa
Birds	36	40	39
Mammals	5	7	10
Butterfly	16	18	18
Reptile	9	9	13
Amphibian	3	2	3

Table 6.Total number of fauna species recorded in three study locations.

4.9. Contribution Of The Ecosystem Service And Agrobiodiversity To Household Livelihood

Provisioning service are the main tangible form of ecosystem service that directly rewards livelihood benefit to farmers. Five kind of important non market provisioning service were valued in the study**.**

Highest value of total provisioning service represent in Kadanbea and lowest value present in Owilla(table 9) Value of different provisioning services are clearly represent the dependency on the community on their forest garden. Provisioning service values inrelated to fire wood is high in Owillla area (table 9).

Species category	Owilla	Etanwala	Kadanbewa
Mean wood density Kg/Cum	650.7	660.5	635
Mean diameter at breast height (DBH , in cm)	31.86	41.74077	40.9
Mean height(m)	6.47	6.25	6.85
Mean Carbon stock t C/ Ha	116.02	155.19	68.16

Table 7. Mean values of carbon stock, wood density, diameter at breast height and mean height of three study sites.

4.11 Willingness To Supply The Ecosystem Services.

This study was include evaluate willingness of forest garden farmers supply the ecosystem services under different policy scenarios(table 12) and willingness of organic food consumer's to pay the additional payment to compensate ecosystem services produce by forest garden farmers.

100% forest garden farmers in all three locations were agreed supply their ecosystem services.

Lowest agreed financial values showed inEtanwala and highest value in Owilla(table 11). These value indicate the opportunity cost of maintain organically their farm land and productivity of land.

No	Types of ecosystem services	Economic value ES value Million US $, ha $^{-1}yr^{-1}$ $USD million		
		WM3b	**IM1b**	**IL3**
01	Market ecosystem services(income of forest garden products)	717.6	3351.4	14793.16
02	global regulation	44.5	319.8	623.9913
03	wind protection	137.5	364	710.234
04	Education	166.4	1196	2333.626
05	Tourism service	166582.2	1196777.4	2335142.9
06	soil nutrient mineralization	88636	6790	41953
07	carbon sequestration	461.7	4438.2	3799.7
08	provisioning	2212.2	1562.6	4520.1
09	Biological control	28.7	249.6	136.7
10	Soil erosion control	27.5	197.6	385.5
11	Domestic cooling effect	83.2	598	1166.8
12	Hydrological service	18	130	253.6
13	Soil formation	22	158.6	309.4
14	Pollination	682.18	4901	9562.7
	Total value of ES	**171237.45**	**1214626.4**	**2374484.5**

Like hood ratio=11.567 and p value=0.03 indicate that there is the significant different between the model (table -20)
Result of this choice experiment convey the message that effective payment option only the individual payment with half annual interval and out of these three policy scenarios(table 12). Mid and high conditionality was significantly accepted by the farmers (p value>0.01).

However, important incidence was detected that the highest preference has gave for high conditionality.

It may be the reason that these farmers already adopted for such inspection done by the company and they believe such an inspection process is beneficial to ensure the credibility of farmer community and the partner company.

Table 8.Economic values of different ecosystem services in three agro ecological zones belong to the study

4.12 Willingness To Buy

This study was conducted in Sambodhi Viharaya based organic farmer market of Colombo 07 and Good market of Baththaramulla.

Type of provisioning service	Value of ecosystem services LKR ha $^{-1}yr^{-1}$		
	Etanwala	**Owilla**	**Kadanbewa**
Food	78000	29928	40152
Fire wood	48051	21624	40080
Herbal medicine	27180	2580	36240
Timber	9708	15852	0
Animal feed	808	8796	1467
Total provisioning services	**163747**	**78780**	**117939**

9 different response against PES were evaluated. The result of evaluation demonstrate that there is significant different market to market (Figure 6). 75% 0f consumers in good market and 46.8% in consumers of Sambodhi Viharaya based organic farmer market willing to pay additionally for ES(figure 6). 47.1%ofcomsumers in Sambodhi Viharaya based organic farmer market and 35.3%Good market of Baththaramulla willing to 0-10% and 21-30% respectively(figure 6).

Table 9. Values of different provisioning services of forestgarden in three study locations.

Majority respondent demonstrate that they willing to pay 10% to30% additional payment as price premium according to normal price of the organic products to compensate ES generated through the organic forestgarden farming.

Variable	Etanwala		Owilla		Kadanbewa	
	Mean value	Standards deviation	Mean value	Standards deviation	Mean value	Standards deviation
Age of household head	52.83	10.70	59.13	10.40	53.45	13.11
Size of the forest garden (Acres)	0.764	0.763	3.16	4.97	1.418	1.397
Total monthly income	18949.3	9670.2	38281.25	21148.66	24656.25	13252.32
Total monthly income of forestgarden farming	6701.8	3133.08	14795.22	7213.80	12164.2	5596.47
Monthly saving	525	1097	9781	15363	1513	4958

Table 10: Descriptive statistics of some components of forestgarden farming livelihoods threein study areas.

4.13 Possibility For Replication Of Forestgarden Farming Livelihoods.

Result of willingness of conventional forest garden farmer to convert their farm in to organic forestgardenweresignificantly positive. 71% of them willing to enter the organic farming. 17% not willing and 11% not clear idea to enter the organic agribusiness (figure 7).
Out of this 71% conventional farmers who willing to enter organic forestgardenfarmingwere justified their decision by presenting different reasons.

	Agreed financial values of payment for ES LKR Acre $^{-1}$Month^{-1}	
Location	Mean	Standard deviation
Etanwala	3818.2	1328
Owilla	15692	6921
Kadanbewa	7166.7	3293

Table 11: Finical value agreed the agreed by forestgarden farmers on behalf of supply of ES.

5. DISCUSSION

Structural variation in term of vertical and horizontal demonstrate across the three agro ecological zone. History of land used and size of the land and agro ecological properties mainly are mainly determine the structural variation of forest garden on three study locations.

Owilla and Etanwalaforestgardens are show identical features of Kandiyanforestgarden. As analog forestry properties of Etanwala and Owilla shows high system maturity as well as successional level (Level 4). Kadnanbewa forest garden shows lowest complexity, maturity and successional level (level 3).

Highest floral species richness of demonstrate in Etanwala forestgarden. Reason for the highest pecies richness may. Location of the village it isboundary village of Knuckles conservation forest and therefore dispersal of forest seeds in to the village forestgaden and increase their species richness.

Highestspecies richness of faunal component shows by Kadanbewaforestgardenand it was represent high richness of reptile and arthropods. Kadnbewaremote village and belong to dry zone and still there are several forest patches and these forestgarden provide habitat for the wild life.

Highest wood density was reported in Etanwala and lowest value in Kadanbewa. It is clearly indicate that variation of mean wood density is the critical factor for above variation. Kadanbewa mainly consist with coconut trees and wood density of coconut is comparatively low. Native woody trees dominant in Etanwala with high wood density. Etanwala is

highly wind prone area vegetation in the area evaluated to survive for this extreme environmental condition therefore these trees have comparatively hardwood high wood density..

The total economic value of ES in study sites land were estimated by using experimentation and extrapolation from field to province using both direct numeric and GIS-based extrapolation methods.These 'engineered', designed ormanmadeecosystems do, however, provide a range of important ES (Cullen et al., 2004; Takatsuka et al., 2005). The economy of the country takes into consideration the market value of ES (food and raw materials) but the remaining of theES are never considered as a part of general accounting and remain outside economic decision making. This approach used here demonstrates the value of non-market ES at the field level in addition to the usual market value of ES in forestgarden.

Attribute	**Coefficient**	**significance**	
Individual payment	1.538	0.000	***
Collective payment	0.538	0.340	
Upfront forest garden development payment	0.080	0.230	
No inspections	-0.098	0.358	
Farmer unit leader inspection	0.100	0.021	**
Internal control system officer inspection	1.008	0.000	***

Table 12: Multinomia llogitmodels of preferences for ahypothetical PES program, based on subsamplesofquestioningmethod.*=significantdifferencebetween treatmentandcontrolat α=0.1 level, *= significant at α=0.01level.**

This exercise was necessary because of the increasing importance of the economic value of ES reengineered' landscapes Evidence of ecological disturbances sometimesdoes not generate much attention unless the evidence includes dollar values (Daly, 1998). The information generated in the present work can be used by researchers and policy makers to increase ecological and economic wealth in a sustainable way and a
greater awareness of the ES provision of forest garden can contribute to the 'future-proofing' of agriculture in an increasingly uncertain food-production environment (Kristiansen et al., 2006).
Some researchers argue that the market value of the products in agriculture alsorepresents the value of those ES which help in its production (Heal and Small, 2002).

But unless it is known how much each of these services is contributing towards the production of food, it is difficult to plan for their maintenance and conservation (Daly1998). In the present study, the value of individual ES on arable forestgarden were estimated(as well as the food and fibre values) and this forms the non-market value of ES.

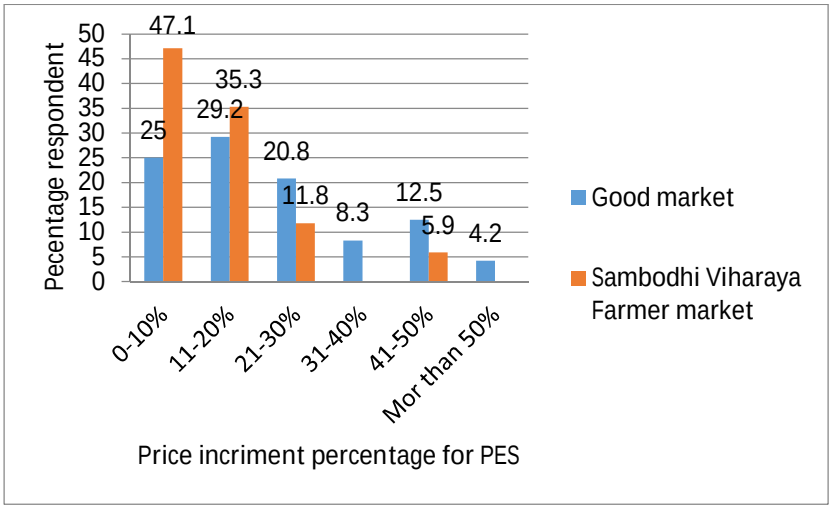


Figure 6: Different range of price increment for ES that willing to pay for ES in two organic farmer market.

These are the 'shadow prices' (Little and Scott, 1976) of ES which are not normallyexchanged in markets but are traded off against each other in agricultural landscapes. The current work put forward a new approach to look at the future of farming by considering ES as an important factor in production and indicates that it should be included in decisions concerning the future of agricultural production (Reid et al., 2005).
This work also demonstrates the utility of GIS-based methods in using a spatial approach to the distribution of ES across agro ecological zones.

The main benefit of this ,village-level census data on forestgarden composition can be spatially extrapolated and visualised, directly reflecting the spatial distribution of forestgarden, their sizes and management activities, and the

resultant impact of these factors on ecosystem services.The differences in total and non-market ES values calculated via GIS, as compared with direct numerical extrapolation, reflects the impact of using spatially-explicit farm data to carry out ES calculations for a given region.
Ultimately, the GIS approach facilitates the exploration and visualisation of how potential changes in management practices and forestgarden types may result in gains or losses of future ES, thereby providing a useful tool for decision-making, discussion and policy.

Profile of livelihood in three study sites shows remarkable variation in term of land size, number of family members in family, monthly income, saving and credits etc.Biophysical, socioeconomic and historical factors are caused these variations.

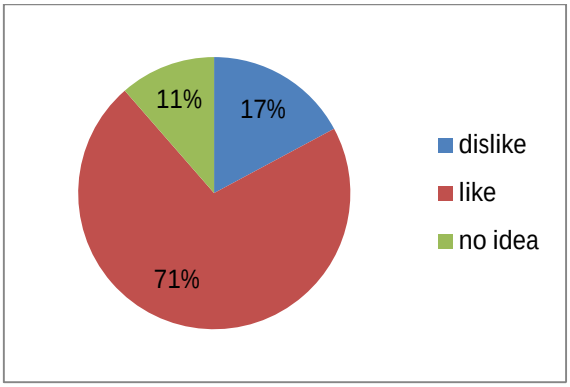


Figure 7: Percentage respondent for willingness to enter the organic forest garden livelihoo

Contribution of the ecosystem service of forestgarden for the household livelihoods significantly vary across the sites with various factors like size of the land, management history, neighbourhood effect (Access road availability). The agro biodiversity managed byforestgarden households, in three sites, produced food, firewood, herbal medicine, animal feed and timberfor consumption. Some theseproducts also generated income through sales. Taken as a whole, this accounts for at least 70-40 percent of household income and at least 50-30 percent of the household's staple food supply. Farmers also appreciated plants for their religious and ornamental value. Forestgarden systems were economically less risky than monocultures, and could generate substantial timber yields of the various native trees.

It is demonstrate variation of level knowledge ofthese three groups of respondent organic forest garden farmers, conventional farmers and organic products consumers related to five different ES were evaluated. Howe ever they have good basic understanding on ecosystem services in generally. That indicate the positive signal to initiate future development project related to ES.

This research has aimed to quantitatively document the preferences of farmers targeted for participation in a future PES programme, and in doing so, predict their likely behavioural response to different PES configurations.Result of choice experiment clearly show Individual payment with six month interval under outside inspection for compliance was more prefer to all communities as policy scenarios s to supply the ES. Organic forest garden farmers already have some experience on supply the organic products under particular payment and inspection condition and result of the choice analysis highly determined by the this previous experiences.

Perception of consumers for PES were vary according to specific characters (income, education and awareness of ecosystem services and previous experiences etc.) Across the different segment of consumers. When promote any PES programme, this situation should consider to design the effective promotional campaign.Identification of potential stakeholder was one of task of this project. Different category of stake holder could be recognize through this research, details

Most important service provide the company was awareness service and it is indicating that although there are potential communities to involve organic forest garden like sustainable livelihood they don't have proper awareness guidance to initiate and develop the relevantlivelihoods alternatives. Policymakers and development decision makers should consider thoroughly on this situation.

Replication of ES related development project among conventional farmers will success basically on the economic benefit rather benefit of environmental or health. In the design of ES related development programme for the conventional farmers should pay more attention on direct economic benefit

Financial constrain concern as man constrain restrict initiation of organicforestgarden farming. They perceive about constrains is basedonthepresent understanding, but it will not necessarily be the reality and it may change with the understanding and experience of new form of livelihood.

6. CONCLUSION

Finding of the study clearly concluded that forest garden system is complex and mature and stable ecosystem in structurally and functionally. Forestgardens are act as niches for various life form and it is help to sustenance of the floral and faunal biodiversity as well continuity of gene flow.

Forestgardenfarming system had the greatest carbon storing potential among the three types of agroforestry system in thee agro ecological zones because of its high structural complexity. Density of woody trees is the critical factor that effect the carbon content. Structural complexity, biodiversity, species composition, species richness and carbon content are significantly varying across the agro ecological zones.

The ecological and economic value of some of the ES can be maintained and enhanced on forestgarden farming system. This study prove that forestgarden farming system provides a range of ES which can be measured using field experiments and implicit value based on ecological principles by incorporating a 'bottom-up' approach. It provides information for policy and decision makers to consider the financial contribution of different farming practices towards the sustainability of forestgarden farming. Tourism service is the heist potential ES value. Monitory value of ES significantly vary across the agro-ecological zones.

Choice experiment result conclude that high hypothetical preference for instalment payment with half annual interval. Individual payment conditionality individual payment, High and moderately conditionality were effective among the conditionality seniors. Group payment and low- conditionality are in effective policy option.

Result of willingness to accept study conclude that organic products consumers clearly willing to pay for ES additionally 11-30% price premium according normal price of organic products. Ecological wellbeing is the main expectation of organic products consumer, to pay for the ecosystem services.

Finical and land constrain are the main restriction factors that discourage the conventional farmers to enter the organic forestgarden farming.

ACKNOWLEDGMENT

This project was implemented under "pricing island biodiversity project" and funded by biodiversity secretariat of ministry of environment and Mahaweli development.

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