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Assessment of the Contribution of Homegardens to Rural Household Income (Case Study in Pyapon Township, Ayeyarwady Region)

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ဥယျာဉ်ခြံ သီးနှံသစ်တောရောနှောစိုက်ပျိုးခြင်းမှ ကျေးလက်နေဒေသခံပြည်သူများ၏ မိသားစုဝင်ငွေထောက်ပံ့နိုင်မှု အပေါ် လေ့လာဆန်းစစ် အကဲဖြတ်ခြင်း

ရတီစိုး၊ ဒေါက်တာ စန်းဝင်း၊ ဒေါက်တာ မြသန္တာတိုး
သစ်တောနှင့်ပတ်ဝန်းကျင်ဆိုင်ရာတက္ကသိုလ်

စာတမ်းအကျဉ်း

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Assessment of the Contribution of Homegardens to Rural Household Income

(Case Study in Pyapon Township, Ayeyarwady Region)

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Abstract

Although homegardens (HGs) are known to be major contributors to household income of local people in addition to food, fruits, vegetables, fuelwood, building materials and cash income, there is very little quantitative information on the benefits of HGs in our country. The main purpose of this study is to assess the contribution of HGs to rural household income. The study was conducted in Pyapon Township, Pyapon district, Ayeyarwady region in May and August, 2017. Required data for this study were obtained from both primary and secondary source. Three villages of Pyapon Township were selected as study area and a total of 105 households were interviewed to collect the information about general characteristics of households, area and age of HGs, income generation and products from HGs, yield from HGs, market price of HGs products, components of HGs, income from paddy field etc. According to research findings, HGs generated between 750,000 and 1,050,000 kyats/ ha of annual household income. The amount of income provided by paddy field ranged from 250,000 and 350,000 kyats/ha of annual household income. Rural people in the studied area managed their homegardens with one component (muti-species), two components (combining trees and seasonal crops/ trees and animals) and three components (trees, crops and animals). Regression results showed that there was a significant relationship between the size of HGs and income from HGs. The correlation was not significant between the age of HGs and income from HGs. The relationship between components of HGs and income from HGs was also significant.

Keywords: Homegardens, Components, Income, Paddy field

Assessment of the Contribution of Homegardens to Rural Household Income (Case Study in Pyapon Township, Ayeyarwady Region)

Introduction

Myanmar has an area of 676,557 sq. km in the Southeast Asia. Agriculture and forestry industries are the main organs of the Myanmar economy and 70% of total population lives in rural areas (Myanmar Population and Housing Census, 2014). Agricultural land is 19.4 % of the total land area (World Bank 2014). According to Forest Resource Assessment conducted in 2015, 42.92 % of the total country's area is still covered with forests. Annual deforestation rate between 1990 and 2015 was at 407,100 ha representing 0.6% of the total country's area (Forest Department, 2016).This is mainly because of natural and man-made causes including over-exploitation, illegal logging, fuelwood collection, agricultural land expansion, population pressure, conversion of forests to other land uses (Forest Department 2011). Myanmar so far has used two strategies for forest restoration and rehabilitation: (i) forest plantation establishment; and (ii) protection of remaining natural forests (Appanah et al., 2016). Krishnaswamy and Hanson (1999) recommended reducing pressure on forest land for agriculture through improved productivity in farming. Agroforestry is regarded as one of the important solutions to problems related to forest loss and degradation (Krishnaswamy and Hanson, 1999).

Agroforestry is a land-use system that involves socially and ecologically acceptable integration of trees with agricultural crops and/or animals, simultaneously or sequentially, so as to get increased total productivity of plant and animal in a sustainable manner from a unit of farmland, especially under conditions of low levels of technology inputs and marginal lands (Nair, 1993). Agroforestry is not new to Myanmar people especially to the rural farmers since multipurpose tree planting around homesteads, on farm boundaries, in religious areas and in common lands, etc. has been in practice for over centuries (Dah, 2004). Agroforestry is increasingly becoming an important aspect of most farming systems (Tang, 2011). Population development, commercialization of farm products and the use of modern inputs have resulted in increased importance and attention been given to more intensive land use practices such as homegardens (Tang, 2011). Homegardens are traditional agroforestry practices. They may be defined as an intimate association of multipurpose trees and shrubs, annual or perennial plants, of livestock within the household compound with the whole unit being managed by family labor (Fernandes and Nair, 1986). They play a vital role in supporting households (HHs) in many diverse ways such as the provision of food, fuelwood, building materials, fodder for livestock, and cash income among others (Tang, 2011). They are regarded as a source of income diversification and also play a crucial cultural and social role in rural communities (Tang, 2011). They may be seen as a buffer to household resources providing additional food, and in some cases cash income (Mitchell and Hanstad, 2004). Most HHs in rural farming communities keep and manage a homegarden in addition to their main farm (Tang, 2011). Only a few HHs do not have homegardens and this is usually caused by a variety of factors such as lack of land, lack of labor, or destruction of crops by animals.

Objectives

The main objective of the study is to assess the contribution of HGs to household income of rural people.

To achieve the main objective, the specific objectives of the study are;

(i) to identify HGAF practices in the study area based on the nature of components,

(ii) to assess the effect of variables such as HG size, HG age, HG components on the contribution of HGs to HH income and

(iii) to compare the annual household income of HGs with that of paddy field.

Literature Review

History of Agroforestry

By the end of the nineteenth century, establishing forest or agricultural plantations in Myanmar had become an important objective for practicing agroforestry. The change of emphasis was not deliberate at the beginning. At an outpost of the British Empire in 1806, U Pan Hle, a Karen in the Tonze forests of Thararrawaddy Division in Burma, established a plantation of teak through the use of the "taungya" method and presented it to Sir Dietrich Brandis. Brandis is assumed to have prophesied that "this if the people can ever be brought to do it, is likely to become the most efficient way of planting teak" (Blanford, 1958). The taungya system spread to other parts of Burma, Schlich recording in 1867 that he had been shown a taungya teak plantation in its second year in the Kabaung forests of the Taungoo Division. From these beginnings, the taungya practice became more and more extensive. (Lundgren, 1982) defined agroforestry as “agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence.

Homegardens: General Description and Definitions

A homegarden is a micro-environment composed of a multi-species (annual to perennial, root crops to climbers etc), multi-storied and multi-purpose garden situated close to the homestead (Hodgkin and others, 2002). Homegardens (HGs) are common in most tropical countries and they play a vital role in supporting households (HHs) in many diverse ways such as the provision of food, fuelwood, building materials, cooking utensils, fodder for livestock, and cash income among others (Tang, 2011). Several terms have been used to describe these garden production systems, such as “homestead garden, backyard garden, kitchen garden, agroforestry, mixed garden, garden culture, etc” (Muruts and Birhane, 2016). The term “homegarden” is preferred because it stresses the close relationship between the garden and the social group residing at home (Muruts and Birhane, 2016). (Torquebiau, 2000) classifies them as agroforestry homegardens in order to avoid possible confusion with domestic vegetable gardens.

There are several definitions of the homegardens. (Fernandes and Nair, 1986) defined a homegarden as an intimate association of multipurpose trees and shrubs, annual or perennial plants, or livestock within the household compound, with the whole unit being managed by family labor. According to (Landon-Lane, 2004), the area around homes which consists cultivated and non-cultivated plant species is commonly defined as homegardens. Backyard gardens and front yard gardens are synonyms to the homegardens which are used in different areas in the world. Homegardens can be defined as a piece of land with a definite boundary surrounding a homestead, being cultivated with a diverse mixture of perennial and annual plant species, arranged in a multilayered vertical structure, often in combination with raising livestock, and managed mainly by household members for subsistence production (Christanty, 1990; Fernandes and Nair, 1986; Hoogerbrugge and Fresco, 1993; Kumar and Nair, 2004; Rugalema et al., 1994; Soemarwoto, 1987). In accordance with (Soemarwoto and Christanty, 1985), homegardens are defined as a land surrounding houses in which the structure resembles that of a forest, combining the natural aspects of a forest with solutions to the socioeconomic and cultural needs of the people.

Various Systems of Homegarden

The main components of Agroforestry systems are trees and shrubs, crops, pasture, and livestock together with environmental factors of climate, soil, and landform. Other components (e.g., bees, fish) occur in specialized systems (Young and others, 1989). Based on these three basic components, Agroforestry homegarden systems can also be classified according to their practical purposes and component composition as reported by (Hasanuzzaman, 2012; Hoogerbrugge and Fresco, 1993; Nair, 1993) as follows: Agrosilvicultural homegarden system, Silvopastoral homegarden system and Agrosilvopastoral homegarden system.

Materials and Methods

Study Site Description

For field study on assessment of the contribution of HGs to rural household income, three villages of Pyapon Township, Pyapon district, Ayeyarwady region were selected as the study area (Table 1). The selection of the study villages was based on the following criteria.

i. The villages with the presence of homegarden agroforestry (HGAF) practice
ii. The villages where the livelihood of local people are depending on agroforestry practices and
iii. The villages where any research on this topic has not been conducted yet

Table 1. Number of households and population of the studied villages

Name of Villages	HH number	Population		
		Male	Female	Total
War Gon	92	234	216	450
Kanyin Gon	198	495	516	1011
Ba Wa Thit (3)	332	746	738	1484

Location

The study was carried out in Ayeyarwaddy Region. The region is bordered by Bago Region to the north, Bago and Yangon Region to the east, and the Bay of Bengal to the south and west. It is contiguous with the Rakhine State in the northwest. The region lies between north latitude 15° 40' and 18° 30' and longitude 94° 15' and 96° 15'. It has an area of 35,140 square kilometers. The total population of the region is 6,184,829 (National Census 2014 of Myanmar). Most of the population of the region (5,312,229) lives in rural area and (872,600) lives in urban area. The region consists of 6 Districts, 26 Townships, 252 Wards, 1,913 Village Tracts and 12,194 Villages.

Selection of the Studied Villages

War Gon (WG) Village: It is situated in Te Pin Seik village tract, Pyapon Township, Pyapon district, which is located between north latitude 15° 47' and 18° 40' and longitude 95° 25' and 97° 25' . The area of the village is approximately 4 square kilometers. The total population of the village is 450 persons and main economic activities are homegardens practice, farm, mangrove plantation and fishing. The village has started the homegardens practice since 1964.

Kanyin Gon (KNG) Village: The village is located in Ba Wa Thit village tract, Pyapon Township, Pyapon district. The region lies between north latitude 15° 47' and 18° 40' and longitude 95° 26' and 97° 27'. The total area of the village is 6 square kilometer. It has 1011 population and main economic activities are homegardens practice, farm, mangrove plantation and fishing. The village has started the homegardens practice since 1959.

Ba Wa Thit 3 (BWT3) Village: It is located in Ba Wa Thit village tract, Pyapon Township, Pyapon district. The village lies between north latitude 15° 47' and 18° 40' and longitude 95° 24' and 97° 25'. It has an area of 6.5 square kilometers and the total population is 1484. Main economic activities include homegardens, farm, mangrove plantation and fishing. The village has started the homegardens practice since 1958. Location map of the studied villages was shown in Figure 1.

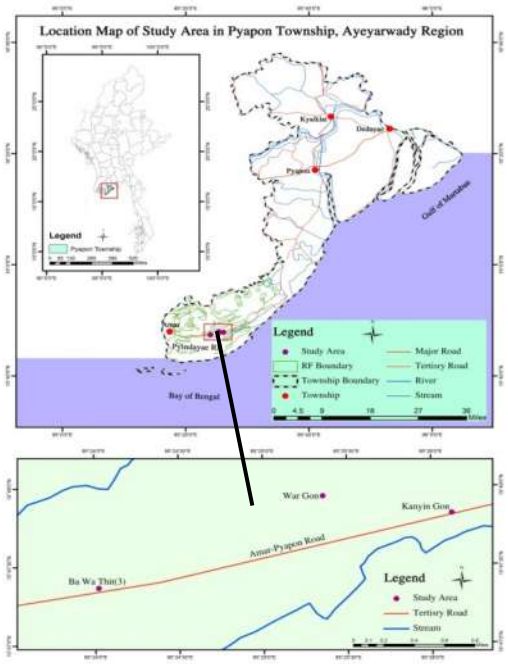

Figure 1. Location map of the studied area

Climate Setting

Climatic data of Pyapon Township were collected from the Meteorology and Hydrology Department, Pyapon Township, Myanmar (Table 2). These data showed that the studied area received rains from May to November. Rainfall in this area is highest in July. The average annual rainfall is 3346 mm. The maximum and minimum temperature in this area is about 29°C and 24°C, respectively (Figure 2).

Table 2. Monthly average precipitation and temperature of Pyapon Township, Ayeyarwaddy Region (2007-2016)

Month	Temperature(°C)	Rainfall(mm)
January	24.11	21.5
February	25.47	14.0
March	27.40	24.00
April	29.41	58.8
May	28.82	387.8
June	27.53	596.0
July	26.86	720.6
August	26.85	661.6
September	27.13	469.7
October	27.92	266.9
November	27.69	105.0
December	25.33	20.0
Total	**27.03**	**278.83**

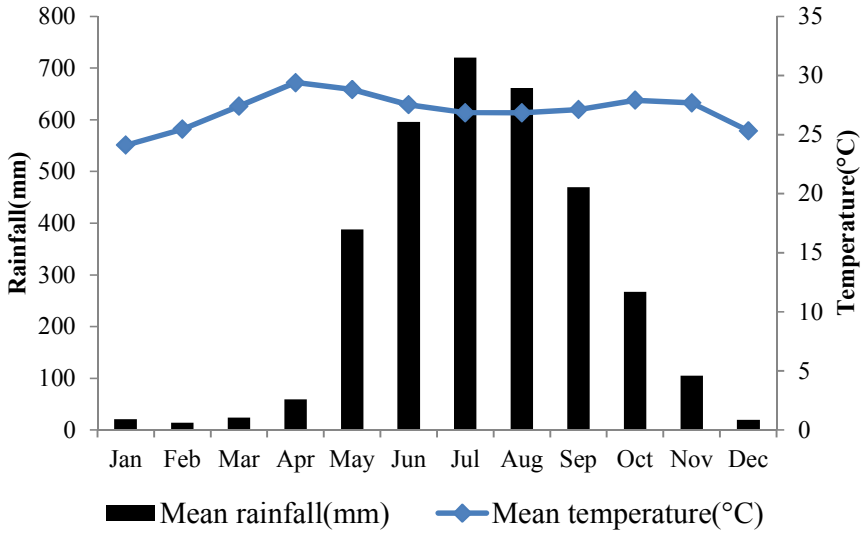

Figure 2. Climate diagram of Pyapon Township

Data Collection Method

Both primary and secondary data were collected for the study. Primary data were obtained through various social economic survey methods including Key Informant Interview (KII), Focus Group Discussion (FGD) and Household Interview (HI). The household survey was conducted using a questionnaire contained both opened and closed questions. During household interview, information about the general household characteristics, the components of homegardens (trees, crops, animals, etc), income from homegardens, inputs and outputs of homegardens, market price of homegarden products, transportation to market and income from paddy field were collected. Each sample household was asked to describe the income sources of household. For homegardens and paddy field, detailed information on the quantity of products and their market prices were asked. And then these data were quantified in monetary terms. Information obtained from Key Informant Interview (KII) and Focus Group Discussion (FGD) helped to validate the information collected through household interview.

Key Informant Interview (KII)

These are interviews with specially selected individuals who have a long period of experience in a certain community or specialized knowledge or skills in a certain topic (Zeeuw and Welbers, 2004). According to (Jackson and Ingles, 1998), people like village elders, local leaders or school teachers, are very knowledgeable about issues, local needs and interests hence are very valuable sources of information. The objective of using key informants is to collect information and more understanding of issues in a short period of time. Care must be taken when selecting key informants to ensure that various categories of people in the society are represented (Zeeuw and Welbers, 2004).

KII method was used to collect general information about the study villages, current conditions of the homegarden practices, history of homegarden, the number of households practicing homegardens within the village and so on. To obtain the target information, knowledgeable person and village leaders who known the information of homegardens were selected as informants.

Focus Group Discussion (FGD)

According to Zeeuw and Welbers (2004), these discussions are held with a specially selected (focus) group usually comprising of 6 to 10 people who have certain factors in common. In these sessions, specific topics are discussed under the guidance of a moderator. This type of discussion is done in order to get the views and perspectives of the participants on a certain issue. It can also be used to tap their knowledge regarding a certain topic or problem (Zeeuw and Welbers, 2004).

In War Gon village, 7 informants who are practicing homegardens have participated in FGD. In Kanyin Gon village and Ba Wa Thit (3) village, 6 informants and 7 informants have participated respectively. Information about the population of the village, the number of households which are practicing homegardens and paddy field, started year of homegarden practice, main income sources of the village, components of homegardens, usage of homegardens products etc were obtained through FGD.

Household Interview (HI)

For household interview, 35 households which are practicing homegardens and paddy field in each village were selected using stratified random sampling method. Detailed information about the income from homegardens in each household, the trees and crop species in homegardens, fertilizer usage, labor input, yield from homegardens and paddy field etc., were collected during household interview.

In WG village, there are 45 households who are practicing homegardens and which represents 49 % of total households of the village. Only 25 households (13%) of the village owned paddy field and total area of the paddy field is 32 ha. Within the village of KNG, 60 households (30%) owned homegardens and 22 households (11%) practiced paddy field. There are 132 households who are practicing homegardens in BWT 3 village and which represents 40 % of total household. About 30 households possessed paddy field and total area is less than 40.5 ha.

Data Analysis

In this study, various statistical tests such as descriptive statistics, ANOVA test and multiple regression tests were used. Descriptive statistics was used to analyze and describe general information of homegardens. To compare the income from homegardens among studied villages, ANOVA test was used. One-way analysis of variance is similar to t-test, but is it is used to compare the mean scores between two or more groups. Post-hoc test was also used to find out which groups are significantly different from one another. Multiple

regression was used to explore the relationship between one continuous dependent variable and a number of independent variables or predictors (usually continuous). Multiple regression is based on correlation but allows a more sophisticated exploration of the interrelationship among a set of variables.

Results

Classification of Homegarden agroforestry (HGAF) practices based on the nature of components

Classification of HGAF practices based on the nature of components such as trees, crops and animals is stated in table 3.

Table 3. Classification of HGAF practices based on the nature of components

Nature of components	WG	KNG	BWT3	Total
1 component (multi-spp.)				
Trees	4	2	4	10
2 components				
Trees, animals	29	14	4	47
Trees, crops	0	14	18	32
3 components				
Trees, crops, animals	2	5	9	16
Total	**35**	**35**	**35**	**105**

According to research findings from HH interview, most HHs in study villages managed homegardens with two components such as combining trees with animals or trees with seasonal crops. One component HGs including multi-species trees, two components HGs containing trees and animals or trees and seasonal crops and three components HGs consisting of trees, crops and animals can be found in the study area.

Information about HGs and Paddy Field

The size of HGs, their age and income provided by HGs to households were described in table 4. In this table, the average farm size, yield from paddy field per hectare and annual income from paddy field were also displayed. In all study villages, all respondents (N=105) practiced home gardens while only 53 respondents (50% of total respondents) have farmlands.

The average land size of homegardens is 1.16 ha and the average age is 23 years. From their homegardens, they received annual income of 869,000kyats per hectare and HG practice is the main income source for households of the villages. The growing of paddy on their farm is another major income source. The average paddy field size that the farmers cultivated is 0.99 hectare and yield from these paddy fields is about 51 tin per hectare. They supplied the annual household income about 291,000 kyats per hectare. Hence it was found that the income from HGs is much greater than those from paddy field in all studied villages.

Table 4. Average size, age, income of HGs and paddy field with standard deviation

Variables	Unit	Average
HG (N=105)		
Size	ha	1.16 ± 0.93
Age	year	23 ± 10
Income	(000) kyats/ha	869 ± 424
Paddy Field (N=53)		
Size	ha	0.99 ± 1.24
Yield	tin/ ha	51 ± 13
Income	(000) kyats/ha	291 ± 78

Contribution of Income by Components of HGs

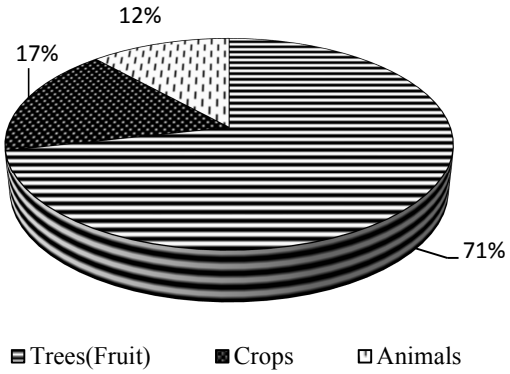

Figure 3. Income Contribution from components of HGs

Considering income generation from each component of HGs, trees contribute to 71%, crops 17% and animals 12% of the total HG income in studied villages. According to figure (3), income generation from trees stands the first place, crops in the second place and animals in the final place. Trees especially fruit trees in HGs gave the highest proportion of annual household income. Fruit trees supply 86% of total HGs income to the households of homegardeners. Among the fruit trees species, *Cocos nucifera* L. (Ohn), *Areca catechu* L. (Kunthi- pin), *Anacardium occidentale* L. (Thiho-thayet) etc., are the major species that can support the highest percentage of HG income to households of homegardeners. The amount of household income obtained from selling building materials and bamboo is second and third highest and finally the amount of income from fuelwood. The amount of income from selling building materials, bamboo and fuelwood is 8%, 5% and 1% of total HGs income respectively.

Correlation between HG Income, HG Size, Age and Components

According to regression results as shown in table 5, there was a significant correlation between the size of HGs and income from HGs. The relationship between age of HGs and income from HGs was not significant with p-value 0.525. There was a significant relationship between components of HGs and income from HGs.

Table 5. Summary statistics, correlations and results from the regression analysis

Independent Variables	Unit	Correlation
HG size	ha	0.62**
HG age	year	0.09
HG components	trees, crops, animals	0.34**

Note : Dependent variable is HG income. *p < .05 ,**p < .01, ***p<.001

Composition of HG Species by Different Use Category

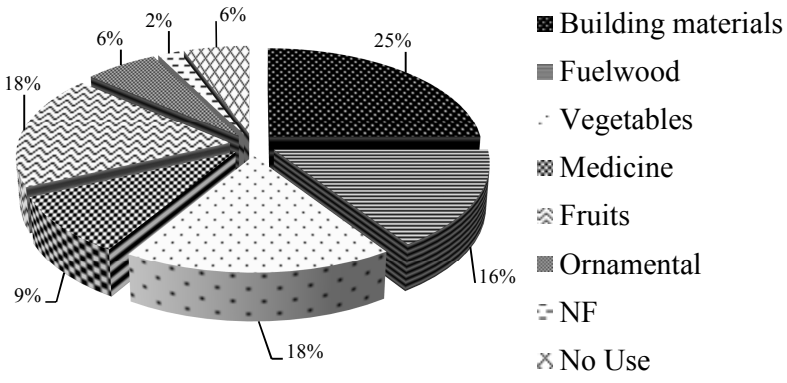

Figure 4. Species composition by different uses in HGs

Detailed information on the uses of each species of HGs is shown in (Appendix 1). Hoemgardeners used the species in their homegardens for various purposes such as building materials, fuelwood, medicine, fruits, and vegetables and so on. Some species were used for one purpose (e.g used for timber or fuelwood or medicine) while the others were used for more than one purpose (e.g used for timber, fuelwood and medicine or fruits, vegetables and ornamentation). A total of 129 species were found in all studied villages. Most of the species 25% is used as building materials, 18% as fruits, 18% as vegetables, 16% as fuelwood, 9% as medicine, 6% as ornamentation, 6% as no use and 2% as natural fertilizer for seasonal crops (figure 4).

Table 6. Uses of Plant species by habit of plants (the values are in percentage)

	Trees (n=70)	**Bamboo** (n=6)	**Shrub** (n=23)	**Climber/Creeper** (n=13)	**Herb** (n=17)
Building materials	40	100	13	15	0
Fuelwood	31		9	0	6
Vegetables	14		22	46	47
Fruits	37		4	0	12
Medicine	6		30	15	12
Ornamental	4		22	0	12
Natural Fertilizer	1		4	0	6
No Use	1		17	23	6

According to the results in table 6, there are 40% of trees species which are used for building materials, 31% for fuelwood, 14% for vegetables, 37% for fruits, 6% for medicine, 4% for ornamental purpose and 1% for natural fertilizer. All bamboo species are mainly used for building materials. However, most of the shrub species are used for vegetables, medicine and ornamental purpose. There are 13 climber/creeper species which are used for building materials, vegetables and medicine. Most of the herbaceous species are used for vegetables.

Comparisons among villages

Average Size, Yield of HGs and Paddy Field

Average sizes of HGs among studied villages are shown in Table.7. WG and KNG villages have nearly the same size which is about 0.78 and 0.76 ha. Average HGs size of BWT3 village is bigger than other two villages which is about 1.96 ha. The average size of paddy field is similar in trend with the size of HGs. WG, KNG and BWT3 villages have the paddy field with average size of 0.67, 0.52 and 1.37 ha respectively. Yield from paddy field is not so different among the studied villages and yield per hectare ranged from 49 to 55 tin.

Table 7. Average size, yield of homegarden and paddy field in study villages

Villages	**Average HG Size (ha)**	**Average Size of Paddy Field(ha)**	**Average Paddy Yield/ha**
WG	0.78±0.28 (n=35)	0.67±1.43 (n=19)	55±13
KNG	0.76±0.24 (n=35)	0.52±0.12 (n=20)	49±10
BWT3	1.96±1.24 (n=35)	1.37±1.09 (n=14)	49±17

The Age of HGs in Studied Villages

Table 8. The age of HGs by villages

Villages	Range of HG Age (yr)	Average HG Age (yr)
1WG(N=35)	2 - 40	21 ± 10
2KNG(N=35)	18 - 40	24 ± 6
3BWT3(N=35)	4 - 58	24 ± 12

According to the results as shown in table 8, the average age of all studied villages is very similar. The studied villages have average age around 20 years.

Income from HG and Paddy field

The average annual income of households of homegardeners in studied villages ranged from 750,000 to 1,050,000 kyats per ha. Post-Hoc test results showed that there was a significant difference of income from HGs among three villages at the significant levels (p=0.02). The difference in income from HGs was not significant between WG and KNG villages at the significant levels (p-value) of 0.051. Between WG and BWT3 village, there was also no significant difference of income from HGs at the significant levels (p-value) of 0.99. There was a significant difference of income from HGs between KNG and BWT3 villages at the significant levels (p-value) of 0.038. Comparison of average income among the studied villages was shown in figure (5).

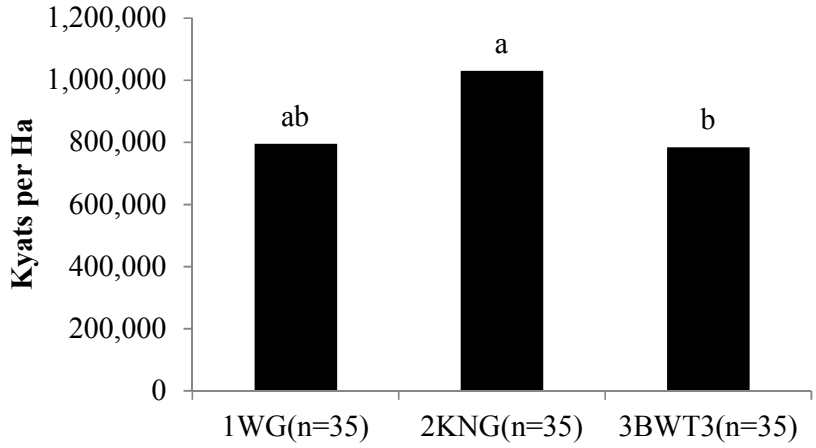

Figure 5. Average income from HGs among villages (The same letter denotes "no significant" different between villages and the different letter shows significance at 0.05.)

When comparing the proportion of income from paddy field among the studied villages, there was no significant difference at the significant level (p-value) of 0.099. In WG village, local people received 317,000 kyats per ha from their paddy field. Paddy field of KNG and BWT3 village contributed to 289,000 and 258,000 kyats of annual household income per ha respectively (figure 6).

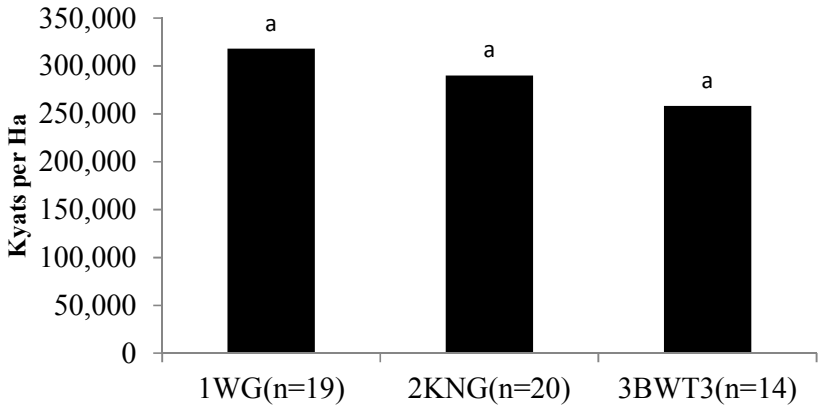

Figure 6. Average income from paddy field among villages (The same letter denotes "no significant" difference between villages.)

Considering the average income from HGs and paddy field per ha, HGs income is much greater than income from paddy field in all studied villages. Average annual paddy yield from their paddy field of WG village is 55 (tin)/ha and annual income generation from paddy field is 317,785 kyats/ha. In KNG village, average annual paddy yield is 49(tin)/ha and contribute 289978 kyats/ha to annual household income. Average annual paddy yield of BWT 3 village is 49(tin)/ha and contribute 258026 kyats/ha to annual household income.

Discussion

Components of HGs

This study showed that most of the sampled households had homegardens composed of trees and animals or trees and seasonal crops. The results of this study are in line with some other studies around the world. Soemarwoto (1987) stated that seasonal crops and trees are major components of homegardens in Nepal while Zaman et al., (2010) also recorded the similar results in homegardens of Bangladish. There are some interactions between the components of HGs such as trees, crops and animals. Animals were reared in homegardens and the trees in the HGs gave shade to them. The leaves of *Albizia procera* (Roxb.) Benth. (sit-pin), *Curcuma petiolata* (malar) and *Melastoma malabathricum* L. (ou-boke) are used as natural fertilizer for *Piper betle* (betel). According to homegardeners' response, the leaves of these species support the growth of *Piper betle* (betel) and after putting the leaves to the row of *Piper betle* (betel), the growth is improved obviously. Combination of seasonal crops and animals was not found in most homegardens because animals reared in homegardens destructed seasonal crops (e.g *Piper betle*).

Average Size and Age of HGs and Paddy Field

In all studied villages, the average size of the homegardens ranged from 0.76 to 1.96 ha. This falls within the range of worldwide inventory of other tropical homegardens by Fernandes and Nair (1986). The size of homegardens in Philippines ranged from 0.01 to 1.0 ha, the size of Kandyan homegardens in Sri Lanka varied from 0.4 to 2.2 ha, the size of

compound gardens in Kerala was between 0.1 and 4.0 ha, the size of compound farms in South-east Nigeria ranged from 0.2 to 3.0 ha, the size of Chagga homegardens in North Tanzania and Burkina Fasso varied from 0.2 to 1.2 ha and 0.1 to 0.8 ha and the size of Kitchen gardens in West Indies varied from 0.01 to 0.5 ha. The total land size of HGs and paddy field of sampled households in WG village is 27.13 ha and 23.94 ha. Among the sampled households of WG village, only 19 households owned paddy field. This means that only 19 sampled households practiced homegardens plus paddy field. The other sampled households practiced solely homegardens. The average HG land size of WG village is 0.78 ha and that of the farm size is 0.67 ha. In KNG village, total HG size is 26.48 ha and farm size is 10.32 ha. There are 20 sampled households who are practicing homegardens and paddy field together. The other sampled households owned only homegardens. In KNG village, average HG land size and average farm size are 0.76 and 0.52 respectively. BWT3 village has the total HG size of 68.62 ha and farm size of 19.23 ha. Only 14 sampled households practiced hoemgardens together with paddy field. The average HG land size is 1.96 and average farm size is 1.37. The average age of homegardens is between 21 and 24 years. Minimum age of HGs in WG village is 2 years and maximum age is 40 years. In KNG village, minimum and maximum ages of HGs are 18 years and 40 years respectively. Minimum and maximum ages of HGs in BWT3 village are 4 years and 58 years.

Average Income from HGs and Paddy Field

The amount of income provided by homegardens to households was greater than the income obtained from paddy field. According to Kyaw Moe Aung (2006), Kachin homegardens also give more income than paddy field. In Myitkyina district, homgardeners received average income approximately 128,000 kyats from their homegardens. Average income from their paddy field is nearly 88,000 kyats (Kyaw Moe Aung, 2006). Similar results were described by (Ali, 2005) who stated that uses of home generated inputs at no or low cost make homegardens economically more efficient and sustainable compared to non-homegarden rice farming. According to the results stated by Kyi Phyu Aung (2015), homegardens of Pyapon Township gave income nearly 400,000 kyats which are not calculated on per hectare basis. Tang (2011) reported that the average size of the small homegardens of Burkina Faso was 0.87 ha and they provided the income approximately `500,000 kyats while the average size of medium homegardens was 2.29 and they gave the income nearly 1,000,000 kyats and the average size of large commercial homegardens was 4.43 ha and they supplied the income approximately 2,300,000 kyats.

Homegarden products are not directly sold to the market by homegardeners and they sold these products to the middleman within the village. Transportation to the market is not accessible and cost is very high to reach the market. Rice production in studied villages is not commercial and yield from paddy field is much less. Most of the rice is used for home consumption and only the surplus amount is sold to get additional income. According to the farmers' response, they did not use any fertilizer and pesticides in their paddy field because

most of the rice is for household use. Rice can be planted only once a year and planting season for rice starts between mid-April and June and harvest season comes in December.

The amount of income supplied by homegardens increases as the size of homegardens increases. Similar results were reported by (Tang, 2011) who stated that percent of income from homegarden increases as homegarden size increases. Most of the income from homegardens derived from trees especially fruit trees. Fruits trees such as *Cocos nucifera* L. (Ohn) and *Areca catechu* L. (Kunthi- pin) are the major tree species that provide household income. The same results were acquired by (Tiwari and Tynsong, 2011) who indicated that the important plant species which contributed to the household income were: *Piper betle* (Betel), *Mangifera indica* (Mango), *Litchi chinensis* (Kyetmauk) and *Areca catechu* (Kunthi-pin). These species are fruit tree species and the most percent of income from homegardens also came from fruit tree species in my study. Major seasonal crop that can support homegardeners' income is *Piper betle* (betel). According to the responses from homegardeners, the cost of growing *Piper betle* (betel) in homegardens is very high. The income from growing *Piper betle* (betel) is not sure because this seasonal crop is easy to damage. Household income generation from HGs of KNG village is greater than other studied villages because KNG village received the greater amount of income from selling building materials and fuelwood from HGs than the other studied villages.

Comparison of Results among Villages

When comparing average size of HGs and paddy fields among studied villages, BWT3 village is bigger than other two villages. The average size of paddy field is similar in trend with the size of HGs. WG, KNG and BWT3 villages have the paddy with average size of 0.67, 0.52 and 1.37 ha respectively. The average age of all studied villages is around 21 years. Yield and income from paddy field is not so different among the studied villages and yield per hectare ranged from 49 to 55 tin. Income received from their paddy field ranged from 250,000 to 317,000 kyats per hectare. The amount of income obtained from HGs between WG and KNG village village is not different significantly. Income proportion between WG and BWT3 is not also different. KNG village received more income from HGs than BWT3 village. The proportion of income provided by trees (used for fruit trees, building materials, fuelwood) is higher in KNG village and that is why the village received more income than the other studied villages.

Conclusion

Although homegardens have not been widely researched in various parts of Myanmar, they play a vital role in supporting the household income of local people. The main aim of this study is to assess the contribution of HGs to household income of rural people in comparison with the income obtained from the paddy field. Specific objectives were to identify HGAF practices in the studied area based on the nature of components such as trees, crops and animals and to assess the effect of variables such as HG size, HG age and HG components on the contribution of HGs to household income.

When comparing the average income from HGs and paddy field per ha, the amount of income generated from HGs was found to have a greater amount than the income from the paddy field. The average annual paddy yield per ha ranged from 49 to 55 tin. Most households in studied villages produced paddy mainly for household use and only surplus paddy are sold to the market. Utilization of fertilizers and pesticides in paddy field was not found in studied villages. In the studied villages, HGs practice with two components was mostly found. Annual household income for rural people from their homegardens ranged from 780,000 to 1,030,000 kyats per hectare. According to regression results, here was a significant correlation between the size of HGs and income from HGs. HGs with large land size generated more amount of household income than those with small land size. The relationship between age of HGs and income from HGs was not significant. The age of HGs does not influence the income generation of HGs. There was a significant relationship between components of HGs and income from HGs. The amount of income generated from HGs to household increased as HG components increased. From this study, the quantitative information of the proportion of income contributed by HGs of Pyapon Township to households of rural people was documented. When considering the HGs income described in the above section, the studied area obtained most of the households' income from their HGs and hence the HGs played the vital role for the livelihood of the local inhabitants. The associated component diversity of Homegarden agroforestry enhances the livelihood of the local people by providing socio-economic benefits than paddy field. Providing alternative options of forest products to the local communities was the prime concern to reduce the pressure on natural forests. Homegardens may be regarded as an alternative way to reduce deforestation pressures due to their provision of fuelwood and basic needs for rural people. Paying attention to development of homegardens has significant role in addressing household socio-economy benefits in the future.

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Appendix

1. Different Uses of HGs Species

No.	Common Name	Scientific	B	Fu	V	Fr	M	O	NF	NU	Habit
1	Kokko	*Albizzia saman*	B	Fu							Tree
2	Aukchinsa	*Diospyros ehretioides* Wall.	B	Fu							Tree
3	Awzar	*Annona squamosa* L.				Fr					Tree
4	Banda	*Terminalia catappa* L.				Fr					Tree
5	Bawzagaing	*Leucaena leucocephala* (Lam.) De Wit.		Fu							Tree
6	Danyin-thi(-pin)	*Archidendron jiringa* (Jack.) I.C.Nieisen				Fr					Tree
7	Gwe pin	*Spondias dulcis*				Fr					Tree
8	Kadet	*Crateva religiosa* Forst.			V						Tree
9	Kadiba	*Diospyros discolor* Willd.	B			Fr					Tree
10	Kalaw	*Hydnocarpus anthelmintica Pierre.*			V						Tree
11	Kanazoe	*Baccaurea ramiflora* Lour.				Fr					Tree
12	Kanyin-phyu	*Dipterocarpus alatus* Roxb.ex *G Don*	B								Tree
13	Ka-si	*Vitex pinnata* L.	B								Tree
14	Kha-aung	*Ficus hispida* L.		Fu							Tree
15	Kinbyungyin	*Acacia concina DC.*			V						Tree
16	Kyaung-dauk	*Pajanelia longifolia*	B				M				Tree
17	Kyaung-sha	*Oroxylum indicum* (L.) *Kurz*				Fr					Tree
18	Kyetsu	*Ricinus communis* L.				Fr					Tree
19	Magyi	*Tamarindus indica* L.	B	Fu		Fr					Tree
20	Mahogany	*Swietenia mahogani* L.	B								Tree
21	Malaka	*Psidium guajava* L.				Fr					Tree
22	Malay-sha-padauk	*Acacia auriculiformis A.Cunn.ex Benth.*	B								Tree
23	Mani-aw-ga	*Carallia brachiata (Lour.)Merr.*	B	Fu							Tree
24	Manjan-sha	*Acacia mangium Willd.*	B								Tree
25	Melaluca	*Melaleuca leucadendra (L.) L.*	B								Tree
26	Mezali	*Cassia siamea* Lam.	B	Fu	V						Tree
27	Minbaw	*Caryota urens* L.			V						Tree
28	Myinga	*Cynometra ramiflora* L.		Fu							Tree

29	Nabe	*Lannea coromandelica*		Fu							Tree
30	Nasha, Nwa-sha	*Litsea nitida* (Roxb.) *Hook.f.*	B								Tree
31	Oun-hne	*Streblus asper* Lour.		Fu							Tree
32	Padauk	*Pterocarpus macrocarpus Kurz.*	B					O			Tree
33	Taw-Kanaso	Unknown1		Fu							Tree
34	Te	*Diospyros burmanica Kurz.*				Fr					Tree
35	Thabye	*Syzygium tetragonum (wight) Wall*				Fr					Tree
36	Thabyu	*Dillenia indica*			V						Tree
37	Ohn	*Cocos nucifera* L.	B	Fu		Fr					Tree
38	Ondon	*Litsea glutinosa* (Lour.) *C.B.Rob.*	B								Tree
39	Pant-tha-ka	*Aglaia cucullata (Roxb.)Pellegr.*		Fu							Tree
40	Peinne	*Artocarpus heterophyllus Lam.*				Fr					Tree
41	Pyinma	*Lagerstroemia speciosa* (L.) *Pers.*	B								Tree
42	Salu	*Licuala peltata* Roxb. *ex Buch.-Ham.var.neltata*			V						Tree
43	Shaw-kanyin	*Sterculia parvifolia Roxb.ex G.Don*	B								Tree
44	Sit-pin	*Albizia procera* (Roxb.) Benth.	B						S		Tree
45	Swedaw	*Bauhinia sulphurea Fischer.*						O			Tree
46	Talinekhaung	*Madhuca longifolia (Koen.) Macbride*	B	Fu							Tree
47	Taung tangyi	*Premna integrifolia*					M				Tree
48	Taung-thale	*Garcinia cowa Roxb.*				Fr					Tree
49	Thanut	*Cordia dichotoma Forst.*			V						Tree
50	Thayet	*Mangifera indica* L.	B	Fu		Fr					Tree
51	Thiho-thayet	*Anacardium occidentale* L.				Fr					Tree
52	Thinbaw-letpan	*Ceiba pentandra* (L.) *Gaertn.*				Fr					Tree
53	Zaung-yar	*Averrhoa carambola* L.				Fr					Tree
54	Zaw gyi	*Quercus velutina*						O			Tree
55	Ye-thapan	*Ficus glomerata* Roxb.		Fu							Tree

56	Yemane	*Gmelina arborea Roxb.ex Sm.*	B	Fu							Tree
57	Thitseint	*Terminalia belerica* Roxb.	B			Fr					Tree
58	Zibyu	*Phyllanthus emblica*				Fr					Small tree
59	Ye-yo	*Morinda citrifolia* L.				Fr					Small tree
60	Thanat-gyi	*Cordia wallichii* G. Don.								x	Small
61	Thanbaya(-pin)	*Citrus aurantiifolia (Christm.)Swingle*				Fr					Small tree
62	Thinbaw(-pin)	*Caryota urens* L.				Fr					Small tree
63	Thit phyu	*Wendlandia glabrata* DC.	B	Fu							Small
64	Shauk(-pin)	*Citrus aurantium* L.				Fr					Small tree
65	Sawbya	*Pterospermum tincotorium (Blanco) Merr.*		Fu							Small tree
66	Sun- Lethe	*Caesalpinia coriaria* (Jaeq.) *Willd.*			V		M				Small tree
67	Myat-ya	*Micrcocos paniculata* L.	B	Fu							Small tree
68	Kunthi(-pin)	*Areca catechu* L.	B			Fr					Small tree
69	Htamin-Zout	*Glochidion ellipticum Wight*		Fu			M				Small tree
70	Byit chin	Unknown4	B	Fu	V						Small
71	Htiyo-wa	*Thyrsostachys siamensis (*Kurz *ex Munro) Gamble.*	B								Bamboo
72	Wa Kyu	Unknown2	B								Bamboo
73	Wa payaung	*Dendrocalamus brandisii*	B								Bamboo
74	Wa-bo, Wabo-gyi	*Dendrocalamus giganteus Wall.ex.Munro*	B								Bamboo
75	Wanet	*Dendrocalamus longispathus (Kurz.) Kurz.*	B								Bamboo
76	Wa-ya	*Oxytenanthera nigrociliata (Buse) Munro*	B								Bamboo
77	Naga-mauk	*Leea indica* (Burm.f.) Merr.					M				Shrub
78	Nga yok thee	*Capsicum annum* L.			V						Shrub
79	Nget-gyi-daun	Unknown 6								x	Shrub
80	Ngayan-padu	*Clerodendrum indicum (L.) Kuntze*			V						Shrub
81	Phon-mathein	*Blumea densiflora*								x	Shrub

82	Khaung-yan	*Hibiscus rosasinensis L.cv.*						O			Shrub
83	Thamon	*Boscia variabilis*								x	Shrub
84	Thetyin-gyi	*Croton longifolius Muell Arg.*			V		M				Shrub
85	Thingyan-pan	*Ascocentrum curvifolium*	B	Fu							Shrub
86	Kyi-hmee	*Flemingia strobilifera* (L.) *W.T. Aiton*					M				Shrub
87	Lauk-thay	*Tadehagi triquetrum*					M				Shrub
88	Moe-hman, Say-thoun-	*Allophylus cobbe* (L.) *Raeusch.*					M				Shrub
89	Ou-boke	*Melastoma malabathricum L.*							S		Shrub
90	Padegaw	*Alpinia conchigera Griff.*			V						Shrub
91	Ponna-yeik-gyi	*Ixora coccinea* L.						O			Shrub
92	Soon hmwe	*Pandanus odorus* Ridl.			V						Shrub
93	Taw-mahnyo-lon	*Hyptis capitata* Jacq.								x	Shrub
94	Taw-sabe	*Jasminum spp.*						O			Shrub
95	Zin phyu	*Breynia vitis-idaea* (Burm.f.) *C.E.C.Fisch.*	B	Fu		Fr					Shrub
96	Zizawa	*Gardenia jasminoides Ellis*						O			Shrub
97	zalat pan	*Tabernaemontana divaricata*						O			Shrub
98	Ye magyi	*Justicia adhatoda* L.	B								Shrub
99	Taw-ziphyu	*Phyllanthus maderaspatensis*					M				Shrub
100	Bezat	*Chromolaena odorata*					M				Shrub
101	Migyaung-nwe	*Derris elegans*			V		M				Climber
102	Myauk kyein	*Flagellaria indica*					M				Climber/Cre
103	Nabu-nwe	*Combretum acuminatum*								x	Climber/Cre
104	Nga yok kaung	*Piper nigrum* L.			V						Climber/Cre
105	Subok	*Acacia pinnata* (L.)willd.			V						Climber/Cre

106	Sein-nabaw	*Smilax sp.* (S.perfoliata 0*Lour. Or*			V						Climber/Cre
107	Damin nwe	*Stenochlaena palustris (Burm.f.)Bedd*			V						Climber/Cre
108	Danon	*Calamus arborescens*	B								Climber/Cre
109	Kyein	*Calamus aggregatus*	B								Climber/Cre
110	Kyi-ah-nwe	*Trichosanthes tricuspidata Lour.*			V						Climber/Cre
111	Don nwe	*Spatholobus listeri*								x	Climber/Cre
112	gamone gya	*Xanthosoma lindenii*						O			Herb
113	Gonmin	*Amomum corynostachyum wall.*			V						Herb
114	Kyetuywe pan	*Heliconia psittacorum* L.f.						O			Herb
115	Hinnu- nwe	*Amarantus blitoides* S. wats			V						Herb
116	Marlar	*Curcuma petiolata*							S		Herb
117	Myin-hkwa	*Centella asiatica (L.)Urb.*			V						Herb
118	Nanat	*Ananas comosus* (L.) *Merr.*				Fr					Herb
119	pein	*Colocasia affinis*			V						Herb
120	Pein gyi	*Alocasia macrorrhizos (L.)Gdon*			V						Herb
121	Pein kya	*Caladium bicolor*								x	Herb
122	Pein nga chait	Unknown 3			V						Herb
123	PhalanTaung hmwe	*Costus speciosus* Sm.			V		M				Herb
124	Taung-zun-phat	*Phrynium pubinerve Blume*			V						Herb
125	Wetkyok	*Commelina benghalensis*		Fu							Herb
126	Yinbya	*Dichroa febrifuga*					M				Herb
127	Nga-pyaw	*Musa spp.* L.				Fr					Herb

Note: B (Building materials), Fu (Fuelwood), Fr (Fruits), M (Medicine), O (Ornamental), S (Soil Conservation), x (no use)