INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 9, No. 4, p. 61-72, 2016
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Valuation of solid benefits of a homestead forestry system in the indus basin, southern Punjab, Pakistan

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Article published on October 30, 2016

Key words: Homestead, Agroforestry, Farm power, Commopoliteness, Tangible

Abstract

To evaluate the benefits of homestead forestry system to the farmers, a study was conducted in southern Punjab (Pakistan) with the hypothesis that "Homestead Forestry system has tremendous potential to enhance the economy and livelihood of the area under study". The results showed that the average farm size, for households was 11.80 ha. The subsistence and economic landholding has a sizes of 5.06 ha and 11.80 ha, respectively. The prices of proceeds produced over the year in homestead forestry of study area were US$330.8. The results showed that 0.25 m3 timber was collected annually per farm out of which 0.07 m3 was consumed and the rest was sold. Average revenue generated by selling homestead timber was US $44.0. Revenue produced in subsistence, economic, and above economic farms were US$20.5, US$80.5, and US$95, respectively. The results showed significant association between cosmopoliteness and agroforestry. Majority (65%) of the NAF was positioned in medium cosmopoliteness category. Agroforestry has positive correlation on the farm income. The comparison of AF versus NAF revealed high farm income to the AF farmers than NAF. The AF farmers with low income (<100000) were about 7 (9%) but in NAF they were18 (22%). Similarly, the AF farmers with medium income (100000-200000) were 29 (36%) while in NAF it was 34 (42%). Also the farmers with high farm income were high in case of AF which is 44 (55%) than NAF where it is 38 (47%) indicating strong financial earning to the AF farmers than NAF farmers.

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Introduction

Homestead agroforestry, is a primordial land-use practice prevailing in rural areas throughout Punjab in Pakistan. These forests are characterized by multi-storied vegetation of trees, (Shisham) *Dalbergia sissoo*, (Kikar) *Acacia nilotica*, (Sirri) *Albizia lebbeck*, shrubs, and herbs, both natural and cultivated nearly living home. These forests are the major source of materials for a multitude purposes, comprising, timber, fuel wood, shelter, structural materials, medicine, fruits and other foods, fodder and resins (Douglas, 1981). Historically, it is noted during the first forest policy of British India adopted in 1894 and the subsequent forest policies 1955 and 1962 of the Pakistan, homestead forests have remained highly significant agroforestry systems (Nair, 1993).

Agroforestry as a viable diversified land use and to develop the rural livelihood and conservation of natural resources has ranked high (Franzen and Mulder, 2007). It must be recognized that timber, fuel wood and fodder, all of which are products that may often be of particularly high importance for local livelihoods (Thompson *et al*., 2010). Agroforestry is mixes of species has higher economic value and synergetic association and also confirms that win-win situation can be accomplished through it and provide has benefits to small farmers (Kessler *et al.,* 2012; Deheuvels *et al.,* 2014). Prime role of homesteaded trees plantation in generating direct access to diversity of nutrient rich foods and complementary food sources during seasonal slight period (Marsh 1998). Homestead forestry is multi-functional landscape that provides employment and income generation opportunities to households (Weerahewa *et al.,* 2012). The same or a little improved forms of such land use occur in many subtropical and tropical regions, such as Indonesia (Christanty *et al.,* 1986), Tanzania (Soini 2005), and West Africa (Kumar and Nair, 2004). Home-gardens are traditional and maintained for household eating and a surplus household income through the sale of proceed, and environmental benefits e.g., controlling the microclimate of the homestead.

A number of accounts designate the composition, structure, and biodiversity of home-gardens in several parts of the world (Millat-E-Mustafa *et al.,* 1996; Abebe2005; Acharya 2006; Peyre *et al.,* 2006; Fernandes *et al.,* 1985; Kabir and Nair, 2009). However, there is also a need for an inventory of the products and costs related with these systems. Furthermore, the environmental, social, cultural and nonmarket benefits in case of homesteaded plantation such as biodiversity conservation, aesthetics, carbon sequestration, microclimate up gradation, and providing wildlife habitat are predicted to be valuable outputs however, no quantified data exist to support this hypothesis (Mohan, 2004). However, some studies addressed the subsistence income obtain through the home-gardens, very few endeavors have been done to measure the detailed solid benefits and environmental benefits provided by these systems. (Mohan, 2004 and Mohan *et al.,* 2006) in their study on valuation of socioeconomic and ecological benefits provided by homestead trees plantation, tried a financial analysis for a typical home-gardens year in Kerala, India. (Babulo *et al.,* 2009) analyzed the role and implication of forest environmental products in the income of rural household and studied its effect on northern Ethiopia rural economic e.g. evaluation of rural poverty and inequality. However as noted by (Mohan *et al.,* 2006) the lack of studies counting the economic value of homestead trees is due to three main reasons first, these systems have high and variable levels of biodiversity that makes data collection time rigorous and error prone, second, these systems deliver some benefits that are intended to be of particular use to certain farmers community only, and thirdly, these are conventional systems, which have existed from hundreds of years, and the benefits apprehended in the past may not be precisely quantified due to inadequate availability of data.

This finding is a part of an ethno botanical research project, the objective of which is to analyze and quantify the benefits and total financial worth of agroforestry home-garden systems in flood affected area of the Indus basin at south Punjab Pakistan.
The total economic benefits (TEB) of home-gardens is the summation of the use and non-use values include direct use values (e.g., fuel, timber and forage), indirect use values (e.g., flood mitigation, soil conservation), option values (e.g., biodiversity) animation values (e.g., endangered species) and bequest values (e.g., habitat) (Pagiola *et al.,* 2004), no study has been conducted to evaluate the economic role of homestead forests and the factors affecting homestead forest production in the southern Punjab of Pakistan.

Furthermore, I endeavor to quantify the tangible benefits resultant from tree based products. These findings also examine the factors influencing annual output and established associations among variables related to input, output, and income. The objectives of this study were to evaluate the role of homestead forests in the household economy, examine if forest production varies across different landholding classes, investigate the relationships of species richness, landholding size, cosmopoliteness, agroforestry knowledge, and farm income size as contributory factors for homestead forest production, explore the relationship between forest benefits and cost and to investigate the attitudes of homestead forest owners/farmers toward key socioeconomic of household.

Material and methods

Agriculture is the core economic activity followed by small business and nonagricultural labor. The major agricultural crops include high-yield variety (HYV) Sugarcane, paddy, cotton, wheat, pulses, mustard, potato, vegetables, spices, and other minor crops. A wide variety of trees and shrubs, Sirri, Mango, Shisham and acacia that surround the village homesteads.

The major function of rural homestead trees is the production of various products for subsistence. A second important function is income generation activity in cash and most of this income is resultant from tree-based resources (Kehlenbeck, 2007). Collection of a broad spectrum of products including fuel wood, timber, forage, construction materials, medicines, vegetables, and so on are described in the literature. However, here I hypothesize that households most frequently harvest three tree-based resources to encounter these primary and secondary functions: fuel, timber and forage. Though (Kikar) Acacia nilotica is a tree based product it is consumed as a substitute of timber in rural areas throughout Punjab Pakistan in huge quantities. The financial value of fodder was not accounted for due to the difficulty to determine the amount consumed by livestock and because it is traded at lower scale.

To evaluate the monetary value of these tree based products was complicated since they were both consumed by the household as well as sold in the market for cash income. The monetary benefits that farmers received through selling the products in the market were noted. In such situation where they were unable to recall the precise amount, the estimated units sold were multiplied by a pre-determined market price. The output values of the consumed product in the previous year were calculated by multiplying the units consumed by the existing market price of that product.

To determine the net tangible benefit (NTB)2 per annum, costs of production in several forms like inputs including labor, planting materials, fencing, fertilizer and pesticide application, transportation, and contingencies, were also determined into account. Labor inputs were provided in both forms the household and hired labor. Hired labor cost was easy to determine. However, household labor cost was difficult to assess because there was no organized labor market and substitute opportunities were also limited. We thus calculate total incurred cost both with and without including household labour.

The study area situated at two Tehsil Council, in which, one Tehsil council is Layyah at District Layyah and second one is Tehsil council Kotadduat District Muzaffargarh both are situated in the southern part of Punjab Pakistan and located between 24°and 27° north latitudes and between 61°and 75°east longitudes (FAO, 2012). Physiographic unit of the Indus Basin covering an area of about 1.12 million sq km and approximately 300 Million people live in the Indus basin (FAO, 2012).

Sampling and data collection

To collect survey data, four UC (Union Council) were selected from the two districts. Using the revenue records registers and information gathered during an exploratory phase, 80households were selected from the four UC (Union council). Households were classified at the criteria of Pakistan Federal Land Commission1975, into three landholding size classes namely, subsistence (5.06 ha), economic (5.06 to 11.80 ha), above economic (above 20.24 ha). A questionnaire structured and then it was supplied to the respondents which comprised of questions related to socioeconomic characteristics of the respondents and its other household members, land use-systems and composition of species in the homestead agroforestry systems. Both farm input and output data were solicited for financial analysis. Respondents were requested to give an estimate of the products that are both consumed within family and sold in the market. Prices of all products were obtained through market survey.

Family labor as farm input was attained through amount of time in a day spent in agroforestry farming. The survey data collected were fed into statistical packages for analysis.

Database management

After the field surveys and other interviews had been completed, the answers were coded according to a separate code list for each survey and then data were entered in pre-designed Microsoft (MS) Access Databases so that the data would be easily accessible (Nelson *et al.,* 2015). Separate databases were used for each of the various types of surveys, which included the forests products surveys of homestead trees household and their non-wood forest products NWFPs and wood forests products WFPs surveys. Each database contained data about each household, hence, it was essential to assign each household a unique code that was used in all the databases; this protocol made it possible to accurately identify any given household and pull information regarding it together from several databases. Also, each Tehsil UC (Union coucial) and village had a unique identifying code that helped facilitate comparisons of data between them.

Statistical analysis

Descriptive statistics (mean and median) and Chi-square test was applied on the data. The analyzed results were presented as descriptive statistics in tables and diagrams.

Results

Socioeconomic, land use characteristics or land use profile of the sample households off our federal land classification 1975, is presented in Table 1.

Table 1. Socio-economic and federal land classification profile of sample households in the south Punjab Pakistan.

FLC	Total farm size (ha)	Homestead area (ha)	Land available for Area (ha)	%	Family Schooling (yr)	HH head schooling (yr)	Annual family income (US$)	Family member Total	Male	Female
Subsistence	5.06	0.16	0.08	50	20.40	7.05	2330.12	6.70	3.40	3.30
Economic	10.12	0.45	0.15	33	25.01	8.25	3271.84	5.20	3.00	2.20
Above economic	20.24	0.75	0.21	28	38.92	9.12	5737.86	4.50	2.00	2.50
Overall	11.80	0.45	0.14	37	28.11	8.14	3779.94	5.46	2.80	2.66

FLC federal land classification 1975, HH Household.

Average farm size, including agricultural land, for all sample households was 11.80 ha, although this high average value did not reflect the real landowning situation since above economic land holding class had average farm size of over 20.24 ha. In variance, subsistence and economic landholding class had average farm sizes of 5.06ha and 11.80ha respectively. Homestead land area, which includes the living quarters and homestead trees resources, was smallest (0.80 ha) for subsistence landholding class and largest (1.53 ha) for above economic landholding class. Existing as well as potential land available in the homesteads to be allocated for homestead trees in subsistence, economic and above economic farm categories were 0.16ha, 0.45ha and 0.75ha respectively and these were 50 %, 33 % and 28 % of the total homestead land areas exclusively.

Table 2. Monetary value of production consumption and sale of four tree-based products across the farm.

Forage	Subsistence	Economic	Above economic	Overall
HC (US$)				
SC (US$)	40.1	54.6	31.2	41.9
Total	20.5	80.5	95.1	65.5
	60.6	115.2	156.4	110.7
Timber				
HC (US$)	30.7	58.5	69.5	52.9
SC (US$)	35.4	32.2	64.4	44.0
Total	65.1	90.7	133.9	96.5
Fuelwood				
HC (US$)	80.2	85.1	89.2	84.7
SC (US$)	40.1	32.2	52.2	41.5
Total	112.3	117.3	141.4	123.6

HC, household consumption; SC, sold for cash.

The overall average family size of the sample households was (Table1). The average family size of subsistence and economic landholding classes were 6.70 and 5.20 while that above economic classes was 4.50. The average period of education for the household heads was 8.14 years, while the average family schooling was 28.11 years. The average annual family income was US$ 3779.94 highest in the above economic homesteads (US$ 5737.86) and lowest in the subsistence homesteads (US$ 2330.12).

Table 3. Quantified benefits and costs of homestead trees across the FLCs.

FLC	Benefit (US$)	Cost (US$)		NTB (US$)		NTB/acre (US$)	
		WithFL	Without FL	WithFL	Without FL	WithFL	Without FL
Subsistence	174.6	54.5	14.9	120.1	159.7	750.6	998.1
Economic	350.2	133.6	37.4	216.6	312.8	481.3	695.1
Above economic	698.4	223.1	102.8	475.3	595.6	633.7	794.1
Overall	407.7	137.0	51.7	475.3	356.0	600.0	791.1

Field survey 2014; (NTB) net tangible benefit and (FL) family labor.

The market price of all products (i.e., forage, timber, and fuel wood,) produced over a year in the homestead plantation of the study area was US$330.8. This amount included the price of the products sold in the market plus market price of family consumption. The maximum amounts of products were harvested on above economic farms (US$431.7) while the lowermost on subsistence farms (US$238). Detailed annual production per homestead, converted to existing market price per homestead for forage, timber wood, and fuel wood, were US$110.7, US$96.6, and US$123.6exclusively. The study findings showed that 0.25 m3 timber was collected annually per farm out of which 0.07 m3 was consumed and the rest was sold. Average revenue generated from selling homestead timber was US $44.0 @ unit price US$315.25/m3). Maximum revenue was produced in the above economic farms (US$64.4) with the lowermost in the subsistence farms (US$35.4) and economic landholdings generated revenue of US$32.2 respectively. Furthermore, 65.10 Mounds (1 mound= approx. 40Kg) forage was collected per year per farm, out of which 18.29mound was consumed by the household livestock's and the rest was sold in the market for cash.

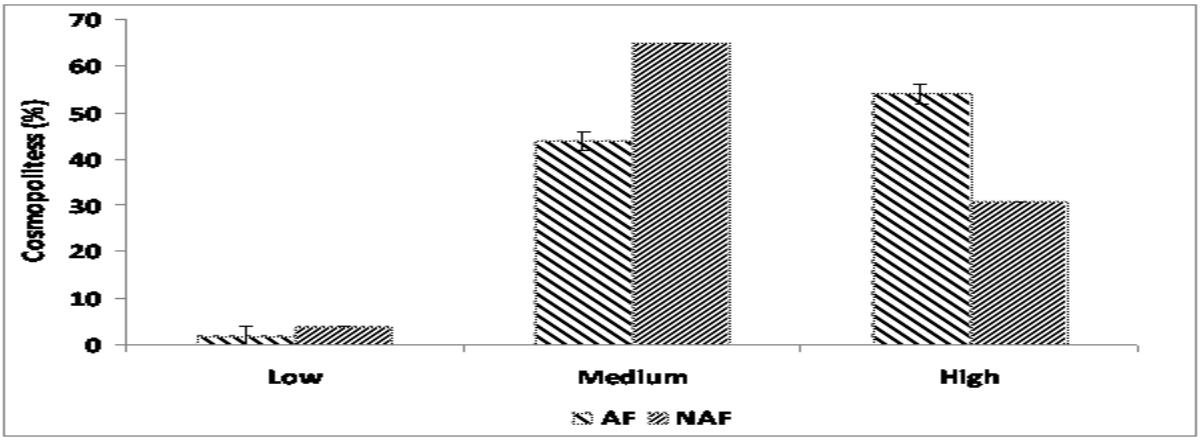

Fig. 1. Enhancement of farmers' inclination towards practice of agroforestry and agriculture crops due to their visit /cosmopoliteness with other farmers. (n=160).

Most frequently harvested forage included *Albizia lebbeck* (Siris) trees. Mutually production and sales increased with the increase of landholding size. Average revenue generated from selling of forage was US$65.5 at average selling price of US$ 1.12/mound. Revenue produced in subsistence, economic and above economic farms were US$20.5, US$80.5, and US$95.1exclusively. Yearly collection of fuel wood per farm from homestead trees was 84.5mounds (1 mound = approx. 40 kg), out of which 64.0 mounds were consumed and the rest was sold. Unit price of sold fuel wood was US$2.784/mound and annual revenue generated from selling fuel wood per household was US$41.5.

Table 3 Represents the outcomes of analysis of costs and benefits and as per acre net tangible benefits produced by homestead trees. The yearly production cost per homestead was US $51.7 without family labor (FL) as cost item then the cost with FL is, US$ 137.0 which is be more than doubled. The yearly net tangible benefit (NTB) per homestead with and without family labor was US$270.6 and US$356.0exclusively. The overall calculated value of annual tangible production per hectare was US$600.0 with FL and US$791.1 without FL cost.

The yearly homestead trees production and income were matched across different farm size categories. Figures 1 and Show vertical Box and Whisker plots for log transformed values of production and income per farm respectively. The data indicate that both mean and median values of income increased with the increase of farm size classes and a similar trend was found in the case of forest production, except in medium farm category. These results suggest that both production and income per farm increase with the in the sampled households.

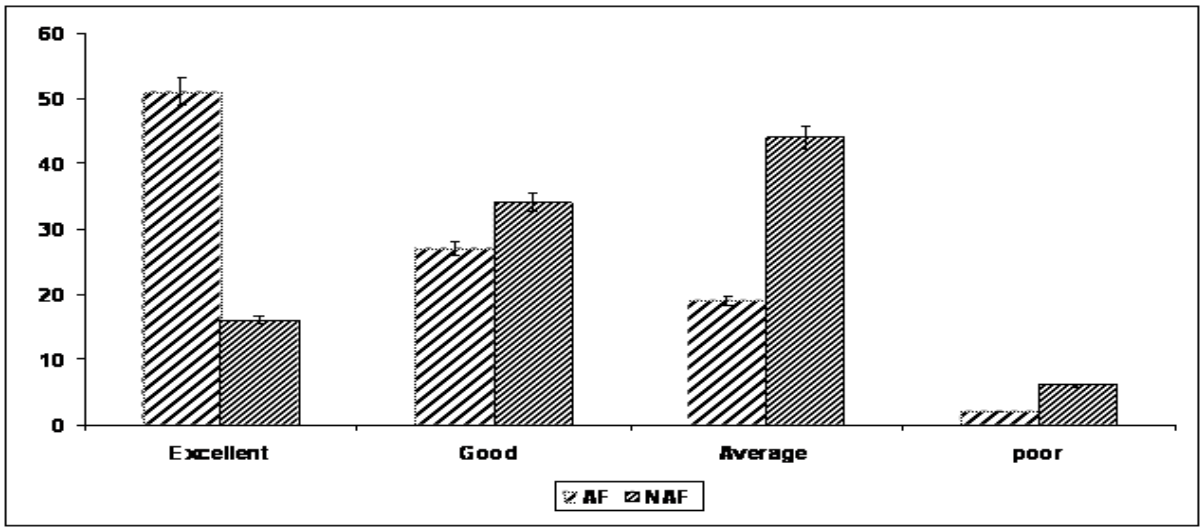

Fig. 2. Tree knowledge and the performance of agroforestry showing high inclination (interest) of the farmers towards agroforestry than conventional farming because of more economical earning due to agroforestry.

Cosmopoliteness

In this study cosmopoliteness was measured, through the frequency of visits made by the farmers to places other than their own village: like major cities, Layyah and Muzaffargarh city, Multan and Lahore. The responses were recorded on a four point liker scale: like often, occasionally, rare, not at all and score ranges from 1 to 4. One respondent can get a maximum score of 16. The total cosmopoliteness score, of an individual was the summated, score for all four items on a scale.

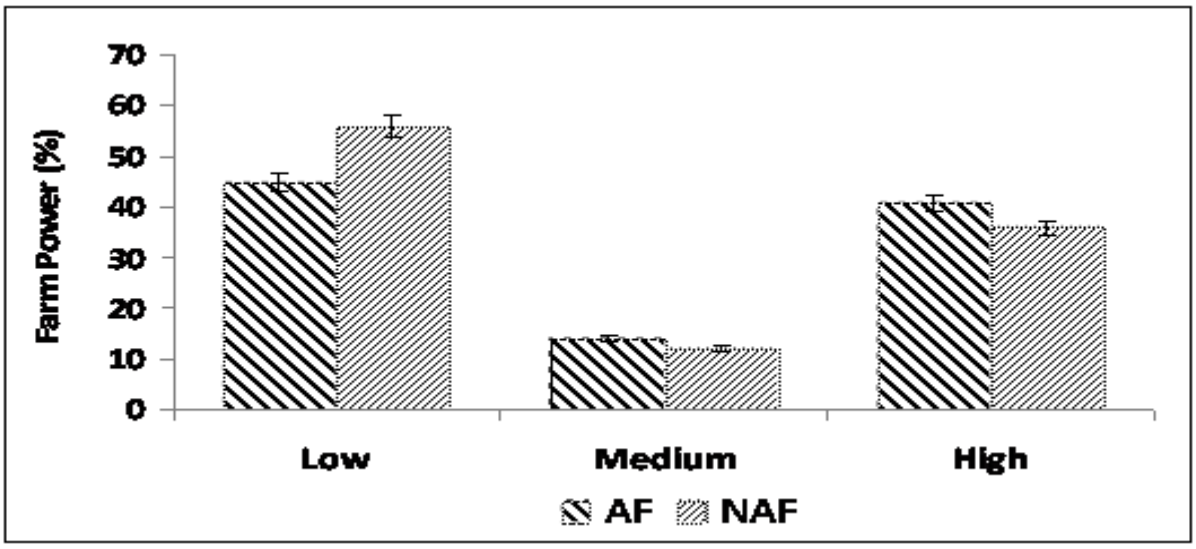

Fig. 3. Utilization of various farm power/tools by respondents in agroforestry and field crops practices because it increases the farmer income. (n=160).

The total score of cosmopoliteness, was then divided into three categories, like high, medium, low. It was found that more agroforestry growers used interpersonal cosmopoliteness channels for seeking information by the agroforestry growers

Results showed that 54% of the respondents were imitated highly cosmopoliteness as compared to NAF who have about 31% of farmers in this category. Further, the large majority (65%) of the NAF was positioned in medium cosmopoliteness category,

AF farmers often visit other village and provincial capital (Lahore) and country capital (Islamabad) as compare to NAF (Figure-1). Our finding heighted that communication with other farmers and new ideas from other farmers could be useful in encouraging positive tendency to new facts and advantageous changes in their attitudes.

Agroforestry knowledge

Statistically significant differences were found between AF and NAF about the knowledge of tree planting. However, farmers practicing AF have excellent knowledge of growing trees rather than NAF The reason is that AF are already involved in tree planting, they have knowledge of silvicultural practices. Further, AF has higher level of education compare to NAF and revealed more cosmopoliteness which helps them to be in touch with new information and ideas about tree growing. These are the major causes; they are more inclined towards agroforestry (Figure 2).

Farm power

Farm power play critical role in the enhancement of farm production. It is confirmed that farm power in agriculture farm effect on the both income and nutrition of farm household. In present survey farmers were classified according to the possession of farm implements. Farming activities are commonly carried out with the help of these farming tools which they possessed; these tools basically represent the farming activities at farm level. However, farmers were classified according to the ownership of farm implements representing their farm power. These were classified into three categories: low, medium and high. Total tools 15 were classified into three categories were made depending upon their efficiency and cost. Tool having low cost and efficiency was given score 1 (e.g., hand cart) while, for medium cost and efficient tools were given score of 2 (spray pump), tools of high cost and efficiency was given score e (tractor, thresher). Data revealed that no significant differences emerged between AF and NAF about the farm power.

Percentage of respondents, among AF is more or less equal in low and high farm power category (45% and 41%) very few (14%) were in the medium farm power category. While, in the case of NAF the percentage of farmers (31%) in the high farm power category is less than AF (Figure-3).

Farm income

Agroforestry has statistically significant effect on the farm income. Our results showed that 55% AF were categorized in high income as compare to NAF which is 47%. The comparison of AF versus NAF revealed high farm income to the AF farmers as compared to NAF. The AF the farmers with low income (<100000) were about 7 (9%) but in NAF they were18 (22%). Similarly, the AF farmers with medium income (100000 – 200000) were 29 (36%) while in NAF it is 34 (42%), likewise the farmers with high farm income were very high in case of AF which is 44 (55%) than NAF where it is 38 (47%) indicating strong financial earning/support to the AF farmers than NAF farmers (Figure 4).

Discussion

Homestead forestry system is usually increase the farm size situated on farmland and consists of living quarters, cattle shed, small vegetable garden having both inner and outer courtyards and a pond also. Existing or absence of any said component in a particular homestead under deliberation it depends on the availability of homestead space or area and household financial position. Spatial arrangement of these components varies from one homestead to another however, it is a common practice that a vegetable garden is planted in the home-garden area and inclined by female household members. Sometimes vegetables and fruit plants are grown on a relatively larger scale. The cattle shed is normally is the part or near the living quarters so that household members can watch them at night. The analysis of land allocation for homestead trees revealed a tendency of decreasing the percentage of existing and potential land for homestead trees plantation with increasing farm size.

Thus subsistence land holding farms allocated a larger portion of their homestead land for forestry practices than the above economic farms in order to prudent utilization of the limited land they owned. The farmers with above economic land holding, in contrast, kept more land vacant in their inner and outer yards for the purposes of ethnic, aesthetics, free movement, and postharvest agricultural purpose.

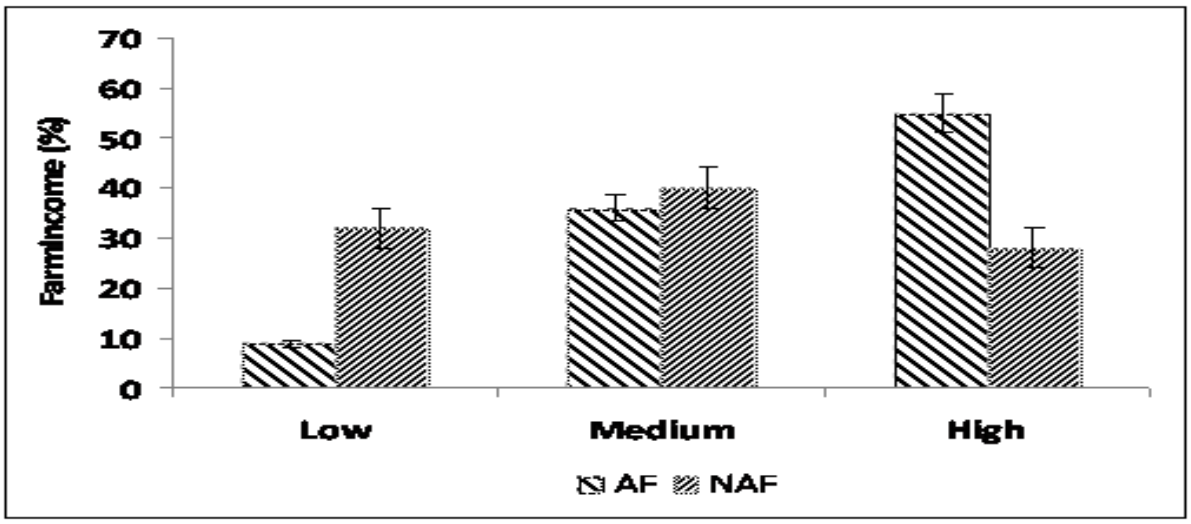

Fig. 4. Income obtained from agroforestry and agriculture crops because it significantly contribute for respondents household improvement of contribution Relation. (n=160).

The field data revealed that a large amount of homestead forestry revenue (US$123.6) came from the harvesting fuel wood. The reason was that fuel wood is the only energy source for daily cooking food. This was the only homestead trees product that was available throughout the year. Similar findings have been described from northern Ethiopia where a major portion of homestead trees income is accounted for by the domestic use value of fuel wood (45%of the total homestead forestry products value) (Babulo *et al.,* 2009). Consumption of fuel wood has direct relation to family size in the household and this is reason that above economic landholding farms with large households consumed a greater amount of fuel wood. Similar findings have been describe from America that in remote and prone zones the purpose of small farmers domestic consumption is the saving of their household expenses which is highly important (Leakey *et al*., 2005). Because of the energy crisis in Pakistan especially rural community/ household regularly consume almost of the fuel wood they produce and a very small amount fuel wood is available to sell in the market (Alam, 2011).

The annual production of homestead timber gradually increased from subsistence to above economic landholding, the amount of timber sold in the local market also followed the same trend.

The overall availability of monetary value of tangible benefits per homestead was US$ 407.7.Sustainability of the total production cost mainly depended on whether family labor input was taken into account or not. Net tangible benefit (NTB) per hectare was calculated by dividing the NTB by average homestead land area, not by area of homesteaded trees. It is notable that on a per hectare basis annual NTB was highest in small farms and lowest in large farms by nearly one third. The productivity of homestead forestry is connected with a number of factors including species composition and diversity quality of planting stock, climatic parameters, management strength. Climatic parameters temperature, aspect, precipitation and soil density of an area influence the growth and development of species cultivated in homesteaded forestry and this ultimately determines the quality of growing stock of the forest (Yang *et al;* 2006).

Clearly, healthy and vigorous vegetation gives higher production. More species richness helps prudent utilization of land potential by improving ecosystem stability and optimizing ecosystem productivity (Rahman, 2006). Hence, composition and type of species planted in home-gardens greatly influence annual production. Farmers usually plant those species that are favored for household consumption but has market value as well. In the study area mango is highly preferred since it grows well, and farmers generally tend to grow mango to sell commercially.

The growth, development, and production of fruit trees are usually high in home-gardens because the farmers select seeds from trees known to bear sweeter and bigger fruits regarding timber species, the farmers tend to depend on the market-produced seedlings. The quality of produced timber is also dependent, among many other factors, on the quality of the planting stock.

The results presented here all indicate that the allocated amount of land is a good predictor of annual production of home-gardens. The regression analysis (results not shown) indicates that the NTBs from home-gardens increase with the increase in the area of land allocated to such land use practices. However, it is important to be cautious in using such models where high degree of accuracy is required since there are many other factors directly or indirectly impacting annual outputs. Furthermore, agro ecological variations also determine the structure, composition, and diversity of home-gardens that ultimately result in variation in outputs. The most notable limitation of the current study is the fact that there remained highly variability throughout year-to-year farm inputs and outputs. This limitation could be overcome if data were gathered over a longer period, and for perennial components over their entire life cycle, which was, of course, beyond the scope of this small research project. Nevertheless, for government policy formulation long-term monitoring of farm inputs and outputs is essential to increase the effectiveness of interventions.

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