PRODUCTIVITY OF THE AGROFORESTRY SYSTEMS AND ITS CONTRIBUTION TO HOUSEHOLD INCOME AMONG FARMERS IN LUSHOTO DISTRICT, TANZANIA

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Abstract

This paper investigates the productivity of the agroforestry systems and its contribution to household income among farmers in Lushoto District, Tanga, Tanzania. Specifically, the study aimed to determine and compare the level of household's farm production and net income between farmers practicing and not practicing agroforestry. A total of 134 respondents from four villages in Soni and Ubiri wards were involved. Data were collected using structured questionnaire, focus group discussion and through non-participant observation. Distribution of responses, central tendency and dispersion, and multiple linear regression analyses were carried using the Statistical Package for Social Science (SPSS) computer software. Results indicate that farmers practicing agroforestry had significantly higher contribution to the household's level of farm production and net income than those who were not practicing agroforestry. Given the average farm size of 3.1 ha, 2.3 cows and 9.2 chicken, the annual production for farmers practicing agroforestry was 425.9 kg for maize, beans 225.7 kg, coffee 101.1kg, and 163.9 bunches of banana, 999.12 litres and 373.5 eggs compared to 342.6 kg of maize, 202.1 kg of beans, 75 kg of coffee, 108 bunches of banana, 1120.6 litres of milk and 338.6 eggs for farmers not practicing agroforestry. The average household annual net income was Tshs 664,992 and 547,608 for farmers practicing and not practicing agroforestry respectively. The income per capita was Tshs 100,756 for farmers practicing and Tshs 82,971 for farmers' not practicing agroforestry. However, the level of household farm production and net income was generally lower compared to most findings from other agroforestry systems. There

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was partial adoption of the agroforestry technologies by some farmers (some households had few numbers of trees/shrubs for timber, fodder, fruits, firewood etc) and poor management which resulted from constraints like inadequate extension services, higher prices of most of the agricultural inputs, low soil fertility and unattractive producer prices. Therefore, overcoming these constraints could improve and probably sustain productivity of the agroforestry systems and its contribution to household income.

Key words: Agroforestry systems, crop production, household income, net income

Introduction

Kitalyi *et al* (2009) reported that Tanzania is listed among the thirteen African countries worst affected by climate change impacts and vulnerability, and having the least adaptive capacities. A review of the status of Tanzania's Agricultural Sector Development Program notes that the country is lagging in achieving its targets on reducing poverty and in achieving the Millennium Development Goals due to low agricultural productivity. Low agricultural productivity is mainly due to low and declining soil fertility. Soil fertility is low and declining due to reduced use of inorganic fertilizers and continuous cropping. The resource poor farmers can not afford the fertilizers in sufficient quantities and sometimes do not apply the fertilizer at all on some of the lands. This is mainly because the farmers can not afford the fertilizers especially after the introduction of the Economic Structural Adjustment Programme in 1989 to 1991 when fertilizer subsidies were withdrawn. Tanzania faces the challenge of revitalizing her agricultural sector by improving the natural resource base: soil, water and biodiversity. Agroforestry, the integration of trees in agricultural landscapes, offers robust options to improve productivity and achieve environmental sustainability.

Incorporating agroforestry systems into national agricultural development programmes offers more affordable and sustainable sources of soil nutrients through deep soil extraction and nitrogen fixation. On the other hand, practicing agroforestry or integrating agroforestry into the farming systems can potentially improve the livelihoods of farmers through improved agricultural productivity (SECAP, 1991; Semgalawe, 1998). Young (1989) defines agroforestry as a collective name for land use systems and practices in which woody perennials (trees, shrubs etc)

are grown in association with herbaceous plants (crops, pastures) and/or livestock in a spatial arrangement, rotation or both and in which there are both ecological and economic interactions between the trees and non-tree components of the system. Tanzania is home to several traditional agroforestry systems that have been in practice for hundreds of years. Some have been documented: the Chagga home-gardens, the related Mara region home-gardens known as *Obohochere* and the traditional *Wasukuma* silvopastoral system called *Ngitili* and those of Kagera. One outstanding aspect of these traditional methods is the use of multi-layered systems with a mixture of annual and perennial plants, which imitate natural ecosystems (O'kting'ati, 1985; Rugalema, 1992).

In effect, many projects with various packages of agroforestry technologies have been launched in various parts of the country. Some of these projects include Soil Erosion Control and Agroforestry Project (SECAP) in Lushoto, Soil Conservation and Agroforestry Project Arusha (SCAPA), "Hifadhi Mazingira" (HIMA), "Hifadhi Ardhi Dodoma" (HADO), Land Management Programme (LAMP), Handeni Integrated Agroforestry Project (HIAP), Hifadhi Ardhi Shinyanga (HASHI) to mention a few. A lot have been done by these projects; starting from the point of sensitization to integration of various agroforestry technologies into the poor rural farming systems (Kerkhof, 1990; Johansson, 2001).

In Lushoto district where the SECAP project has been implemented since 1981, previous studies have shown that, the project has been successful in improving the livelihood strategies of farming households (Kerkhof, 1990, SECAP, 1999; Johansson, 2001). While the contribution of agroforestry to poverty reduction is well documented in many places, there is paucity of information on whether or not agroforestry systems significantly contribute to the farm productivity and household income in Lushoto District. Therefore, this paper examined the productivity of the agroforestry systems and its contribution to household income in the district.

Materials and Methods

This study was carried out four selected villages namely Ngulwi and Ubiri in Ubiri ward, and Soni and Shashui villages in Soni ward in Lushoto district in the northeastern part of Tanzania. The exiting land use pattern in the district is divided into four categories namely dry land farming constituting 58%, tree crops or irrigated area (11%), forest reserves (16%) and grazing areas (15%). This land use pattern makes the West Usambaras one of the most intensely farmed areas of Tanzania (Pfeiffer, 1990).

A cross-sectional research design was adopted in this study because it allows data to be collected at a single point in time without repetition from the representative sample. The reason for the choice of such a design is that, it is easier and economical to conduct especially where resource constraints like time, labour and money dictate the results, as it was the case for this study. Primary data were collected through household questionnaire survey using structured questionnaires with both open-ended and closed-ended questions, focus group discussion with the key informants using a checklist of questions and physical observation, while secondary data were collected through documentary review. The aim was to cross check and verify information obtained through these different methods regarding the topic in question.

The target group for this study was all farmers practicing and not practicing agroforestry in the Lushoto district. The sampling unit was the household. A household in this study is referred to as a single person or group of persons who live and eat together and share common living arrangements i.e. share expenses (URT, 1994). Since for any land use system to qualify as an agroforestry system, there must be woody perennials (trees, shrubs etc) deliberately combined with herbaceous plants and or livestock in spatial, rotational or both in which there are both ecological and economical interactions between the tree and non-tree components of the system (Young, 1989; ICRAF, 1996). In addition, since it was also hardly possible to find a single household's farm without trees and /or shrubs in the study area, then, the criterion used to obtain farmers practicing and not practicing agroforestry was based on the number of trees found in the household's farm. Farmers who had less than 20 trees/ ha were regarded as not practicing agroforestry while those with more than 20 trees were practicing agroforestry.

It was assumed that, other factors being constant, farmers with many agroforestry trees and which are properly arranged and managed could have higher income resulted from positive interactions between the tree and non-tree components of the system(s) than those with fewer trees.

After identifying farmers practicing and not practicing agroforestry; simple random sampling technique was applied to select households from the study villages. Equal number of households from both farmers practicing and not practicing agroforestry in each village were picked for the interview for easy comparison. A random sampling intensity of at least 5% was used to determine the sample size of the households interviewed in each village as described by Boyd *et al.* (1981) cited by Kayunze (1998). Overall, a total of 134 households were selected for the study.

This study was carried out in two phases. Phase one involved a reconnaissance survey. The second phase was mainly based on questionnaire survey. The reconnaissance survey was conducted in order to observe the general conditions of the farming systems; make researcher be acquainted with the study area; select study villages and the sample size required; and pre-test the questionnaires to check for its validity and reliability, to fit the local condition as recommended by Goldman and Macdonald (1987) cited by Kayunze (1998). Questionnaires were pre-tested using 44 respondents from four villages. Eight respondents (4 from participants and 4 non-participants of the agroforestry practices) and 3 key informants were picked from each village. However, most of the questions were responded thus, very little modifications were made to the original questions.

Descriptive and inferential statistics methods were applied to analyse the quantitative data while qualitative data were analysed by using Content and Structural-Functional methods (Merina, 2001). Multiple linear regression model was developed in order to predict whether or not the dependent and independent variables were significantly related and measure the strength of their relationship. The dependent variable, net income of household's farm production was regressed on the independent variables (farm size, household size, number of trees planted, number of livestock kept, varieties of crops grown and cost of production) to find the standard regression

coefficient, the beta weight (ß) of each independent variables, the multiple correlation, R, and the multiple coefficient of determination, R^2. These six independent variables were included because they were thought to be able to account for more of the variation in the dependent variable. The general model used in linear regression was:

$$Y_i = a + b_1x_1 + b_2x_2 + \ldots\ldots\ldots\ldots + b_jx_j + e_i$$

Where:

Y_i = The i^{th} observed value of the net income of the household's farm production (dependent variable).

a = Intercept

b_1 to b_6 = Independent variable coefficients

X1 = Farm size

X2 = Household size

X3 = Number of trees planted

X4 = Number of animals kept

X5 = Varieties of crops grown

X6 = Cost of farm production

e_i = Random error

Results and Discussion

Socio-economic characteristics of farmers

The socio-economic characteristics of farmers examined in this study were sex, marital status, age, household size, farm size, education level and the main occupation. The purpose of choosing

these characteristics was to get general overview of what the respondents are composed of and how these characteristics could influence agroforestry practices towards poverty reduction in the study area. Results in Table 1 show that, the highest percent of farmers (79.1%) were men while only 20.9% were women despite the fact that women are the key players in most of the household's farm activities. The possible explanation for this trend is that the study targeted households' heads as main decision makers of the household affairs. Except for the few households which were female headed, the majority were male headed. Sometimes, women had to respond on behalf of their husbands due to some special excuses like when were not around. Therefore, combining some of the households which were male headed and the female headed; 87.3% of the interviewed farmers were heads of the households while 12.7% not heads of the households. The findings also show that 85.8% of the respondents were married, 6.7% divorced, 3.7% widowed and 3.7% separated.

The study found the age of farmers to range from 22–70 years. The average age was 45 years. Over three quarters (79.1%) were in the age group of 31–64 years, whereas 12.7% were above 64 years and 8.2% below 30 years. This implies that most of farmers were in the economically productive age group with great experience in agroforestry both before and after SECAP. Therefore their experience was very useful in the success of this study. According to Mandara (1998) and Mtenga (1999), household members are considered economically productive from the age of 16 to 64 years. The age bracket below 16 years is children some of whom may be attending schools and others too young to participate in farming activities. The age group above 64 years is considered less economically active because the members are too old.

Table 1: Characteristics of respondents (n = 134)

Variable	Characteristics	Frequency	Percent
Sex	Male	106	79.1
	Female	28	20.9

Marital status	Married	115	85.8
	Divorced	9	6.7
	Widowed	5	3.7
	Separated	5	3.7
Age group	Below 30 years	11	8.2
	Between 30 – 64 years	106	79.1
	Above 64 years	17	12.7
Education level	No formal education	5	3.7
	Adult education	11	8.2
	Primary education	96	71.6
	Secondary education	19	14.2
	Diploma	3	2.2
Farm size	Less than 2.0 ha	51	38.0
	2.0 – 3.0 ha	45	33.6
	More than 3.0 ha	38	28.4

The mean household size was 6.6 persons. The smallest household had 3 persons while the largest had 11. This figure is higher than the district average of 4.7 persons reported in the National Population and Housing Census (URT, 2002) and lower than that of 8.8 persons reported by Moshi (1997) in the west Usambaras. The average household size below the age of 16 years was 3.0 persons, 2.8 persons between 16 – 64 years and 0.8 persons above 64 years. This implies that at least every household in the study area has an average of 2.8 persons who can actively participate in farming activities.

Close to three quarters of respondents (71.6%) had primary education, 14.2% secondary, 8.2% adult education, 3.7% no formal education while 2.2% diploma education. Generally, except for the minority (3.7%) who had no formal education, most of the respondents were educated. This implies that, introduction of various agroforestry innovations in the study area are likely to be successfully adopted because the majority could not only be trained by the extensionists but also read from books and newsletters and other sources of information.

With regard to farm size, over one third of respondents (38%) had farm sizes below or equal to 2 hectares. The mean farm size was found to be 3.1ha. The minimum and maximum farm sizes were 0.7 and 4.5 hectares respectively. However, majority of the households with farm sizes greater than 3 hectares had plots of woodlots some planted with black wattle (*Acacia meansii*) and others planted various tree species for timber, firewood, poles and other building materials among which being eucalyptus and grevillea. Further, observations have shown that there is high farm fragmentation ought to be influenced by the former system of shifting cultivation. Farmers have several farm plots of various shapes and sizes located into different places within and sometimes even out of the sample village. Close to three thirds of respondents (61.2%) complained that their farms were not enough. However, further observations have shown that the average farm size of 3.1 ha could be large enough to meet requirements of most of the reported household size of 6.6 persons. However, most farms were not well managed including adding enough manure and planting improved crop seeds. Historically, the study area had faced serious soil erosion resulted from poor soil conservation measures before SECAP thus leading to low soil fertility. Therefore, if farmers could manage them properly as recommended, will improve the systems productivity and thus meet most of the household daily requirements and surplus for cash income.

Productivity of the agroforestry systems

Various levels of farm production were observed in the study area between farmers practicing and not practicing agroforestry as described in the subsections here under.

Animal husbandry

Findings in Tables 2 and 3 show the distribution of various livestock per household for farmers practicing and those not practicing agroforestry respectively. Nearly every household (94%) keeps at least one kind of livestock. Chicken was the most preferred livestock (88.8%), followed by cows (46.5%), goats (43.8%), sheep (22.4%) and ducks (9.7%). Chicken was the most preferred because it is relatively easy and cheap to manage as needs only small initial capital compared to other livestock species. On average, every household had 9.7 chicken, 2.4 cows, 3.1 goats, 2.6 sheep and 1.2 ducks. The minimum and maximum number was 2 and 25 for chicken, 1 and 5 cows, 1 and 10 goats, I and 6 sheep, and 1 and 4 for ducks respectively.

Table 2: Average number of livestock kept per household for farmers practicing agroforestry

Village	Average number per household				
	Cows	Goats	Sheep	Chicken	Ducks
Ubiri	2.7	3.3	3.3	10.5	2.0
Ngulwi	2.8	3.1	4.8	11.6	1.0
Soni	2.6	3.2	2.6	9.9	0.0
Shashui	2.8	3.9	4.0	9.1	2.0
Average	2.7	3.4	3.7	10.3	1.3

Generally, farmers practicing agroforestry had significantly higher numbers of livestock than those not practicing ($P<0.05$). Sheep and ducks were the least preferred animals in the study area. In Soni village for example, none of the farmers practicing agroforestry kept ducks (Table 2), whereas in Ngulwi and Shashui villages results show that none of them was kept either sheep or ducks among farmers not practicing agroforestry (Table 3).

Table 3: Average number of livestock per household for farmers' not practicing agroforestry

Village	Average number per household

	Cows	Goats	Sheep	Chicken	Ducks
Ubiri	2.0	2.1	2.7	6.6	1.5
Ngulwi	2.0	3.0	0.0	14.4	0.0
Soni	2.1	3.8	3.0	5.7	2.7
Shashui	2.3	2.5	0.0	10.2	0.0
Average	2.1	2.8	1.4	9.2	1.1

Table 4 shows production of milk and eggs by both farmers practicing and not practicing agroforestry. On average, the level of production was significantly different between farmers practicing and not practicing agroforestry ($P<0.05$). Comparatively, farmers not participating agroforestry had higher level of milk production (487.2 litres/cow) than the participants (434.4 litres/cow). The reason for this was that, comparatively, there was less number of farmers not practicing agroforestry who were keeping dairy cattle and majority of them had improved and well managed breeds. The minimum and maximum level of milk produced was 341.1 and 560.2 litres/cow for farmers not practicing agroforestry and 347.4 and 554.2 litres/cow for those practiced agroforestry respectively. Milk production per cow per day ranged from 1.5 litres to 8 litres. This level is low especially when compared to the one reported by Tulchan and Jabbar (2000) of 10 to 30 litres/cow/day under agroforestry systems. This implies that farmers in the Lushoto district still have a long way to go towards improving milk production.

Farmers practicing agroforestry produced more eggs (40.6 eggs/hen/yr) compared to 36.8 eggs/hen/yr for those not practicing agroforestry. The minimum and maximum level of eggs produced was 24 and 60 eggs/hen respectively. Goats and sheep were meant mainly for meat production although the averages per household were too low to justify the intended goal i.e. an average of 3.1 and 2.6 for goats and sheep respectively. There were no goats kept for milk production.

Table 4: Milk and eggs production for farmers practicing and not practicing agroforestry

Village	Farmers practicing agroforestry		Farmers not practicing agroforestry	
	Milk (Litres/cow)	Eggs (Eggs/hen)	Milk (Litres/cow)	Eggs (Eggs/hen)
Ubiri	470.2	43.1	560.2	33.2
Ngulwi	554.2	45.4	510.0	33.5
Soni	347.4	38.1	537.7	44.8
Shashui	365.8	35.9	341.1	35.8
Average	434.4	40.6	487.2	36.8

Farmers were asked to give trends of the level of milk production for the past ten years. Close to half (48.5%) said it was decreasing, 29.1% uniform, 17.2% increasing and 5.2% were not keeping dairy cattle. Milk production have been going down among the majority probably due to poor livestock management practices due to inadequate extension services, high costs of livestock inputs, diseases and insufficient fodder supply from the agroforestry systems. It was however, learnt from focus group discussions that, there are opportunities for farmers to improve their livestock level of milk production. This is because most of the surveyed households (80%) had crossbred stall-fed dairy cows of which if properly managed can improve milk production. The problem was that some of the dairy cattle were not fed well because sometimes farmers were forced to either buy fodder or hire labour to fetch them outside the agroforestry systems which increased livestock production costs. To reduce the costs probably the animals do not get enough fodder thus, the low milk production. Therefore if farmers could improve fodder production then the animals will get enough to eat and thus improve milk production. Studies by ICRAF (1996) and Gatsi *et al.* (2000) have shown higher level of milk production after the improved dairy cattle got enough fodder.

Crop production

Tables 5 and 6 show household's level of production of various crops for farmers practicing and not practicing agroforestry respectively. The level of production was significantly different between farmers practicing and not practicing agroforestry ($P<0.05$). Generally, farmers

practicing agroforestry had higher levels of production than those who were not practicing. On average, farmers practicing agroforestry produced up to 137.4 kgha^{-1} of maize, 72.8 kgha^{-1} beans, 32.6 kgha^{-1} of coffee and 52.9 bunches of banana per hectare (Table 5) compared to 110.5 kgha^{-1}of maize, 65.2 kgha^{-1}beans, 24.2 kgha^{-1}coffee and 34.9 bunches of banana for farmers not practicing agroforestry (Table 6). Considering the observed average farm size of 3.1 ha; farmers practicing agroforestry therefore produced up to a total of 425.9 kg of maize, 225.7 kg beans, 101.1 kg coffee and 163.9 bunches of banana compared to 342.6 kg of maize, 202.1 kg beans, 75.0 kg coffee and 108 bunches of banana from farmers not practicing agroforestry annually.

Several factors could have contributed to these differences. General observations showed that, there were more households (58.4%) keeping livestock especially dairy cattle among farmers practicing agroforestry compared to 36.7% who were not practicing. Therefore majority had enough and cheaply available animal manure to apply in their farm plots for crops production than others not practicing agroforestry who had to buy from neighbours. Also, by using the income obtained from milk production some few farmers practicing agroforestry afforded to buy some suitable hybrids and thus higher level of crops production.

Table 5: Distribution of production of various crops for farmers practicing agroforestry

Village	Maize (Kg/ha)	Beans (Kg/ha)	Cassava Bags/ha)	Potatoes (Bags/ha)	Tomatoes (Baskets/ha)	Coffee (Kg/ha)	Bananas (Bunches/ha)
Ubiri	176.8	104.4	3.1	2.1	66.7	25.5	60.6
Ngulwi	131.1	67.9	1.9	1.2	73.3	25.7	43.3
Soni	135.6	69.4	3.9	1.2	83.2	46.6	52.5
Shashui	105.9	49.5	2.6	1.1	77.3	32.5	55.1
Average	137.4	72.8	2.9	1.4	75.1	32.6	52.9

Table 6: Distribution of production of various crops for farmers not practicing agroforestry

Village	Maize (Kg/ha)	Beans (Kg/ha)	Cassava Bags/ha)	Potatoes (Bags/ha)	Tomatoes (Baskets/ha)	Coffee (Kg/ha)	Bananas (Bunches/ha)
Ubiri	158.7	82.3	2.4	1.9	64.8	11.6	40.9
Ngulwi	92.3	60.9	1.7	0.6	31.5	8.7	30.1
Soni	108.7	56.7	3.1	0.9	60.7	56.7	38.5
Shashui	82.4	60.9	1.6	0.5	45.7	19.8	30.2
Average	110.5	65.2	2.2	0.9	50.7	24.2	34.9

Except for some few types of crops like maize, beans and cassava, which were commonly grown by almost every farmer (practicing and not practicing agroforestry), generally the number and types of crops cultivated varied from one household to another. Some farmers preferred to grow more of the long rain crops while others short rain crops. However, 43% of the surveyed farmers reported uniform trends of the levels of crop production for the past ten years, whereas 40% decreasing and 17% increasing suggesting that majority (60%) are benefiting from the systems productivity although not at optimal level because to them, production has either been uniform or improve to some extent compared to the past. Furthermore, 47% were expecting future productivity of their agroforestry systems to be the same as the present time while 28.4% poor and 24.6% to improve.

Further observations showed that majority of farmers practicing agroforestry had managed to arrest the problem of soil erosion to some extent; firstly by stopping the former system of free livestock grazing of which was accelerating the problem and secondly by planting more plants. With such achievements, future productivity of the systems could probably improve depending on the management system. Apart from arresting soil erosion, farmers need also to frequently add animal manure and plant the recommended improved crop seeds suitable to this area instead of the commonly used local seeds. Study by ICRAF (1996) has shown improvement in productivity of the agroforestry systems especially after using improved crop seeds. For example, yields of

wool and mutton improved from 3.25 to 17.30 tones/ ha as a result of growing improved seeds, which were also well managed.

Comparatively, the observed average yields from farmers practicing agroforestry (Table 5) were generally lower than other yields reported by Fernandes *et al.* (1984), Frozen and Oberholzer (1986), Rugalema (1992) and Moshi (1997). For example, Moshi (1997) reported 156.25 $kgha^{-1}$ of coffee, 92.97 $kgha^{-1}$ of beans, 235.16 $kgha^{-1}$ of maize and 163.28 bunches of banana per hectare from the west Usambaras homegardens. Study by Fernandes *et al.* (1984) showed a total of 412 $kgha^{-1}$ of coffee, 148 $kgha^{-1}$ of beans and 404 bunches of banana per hectare from the Chagga homegardens. In western Nepal, the average annual yield was 899$kgha^{-1}$ for maize, 637 $kgha^{-1}$ for wheat, 206 $kgha^{-1}$ for millet and 186 $kgha^{-1}$ for rapeseed (Frozen and Oberholzer, 1986). The Kagera home gardens were producing up to 200 $kgha^{-1}$ of beans, 135 $kgha^{-1}$ of maize, 175 bunches of banana ha^{-1} annually (Rugalema, 1992).

This implies that, farmers still have a long way to go towards improving the productivity of the agroforestry systems in the study area. Several factors could have contributed to the observed level of production including the problem of low soil fertility, expensive farm inputs, and unattractive producer prices to some crops. There was also partial adoption of the agroforestry technologies as shown by some farmers who had few numbers of tree species and shrubs in their farms. Therefore, overcoming these constraints could probably lead to opportunities of improving the systems' productivity.

Trees and shrubs production

Table 7 shows the average, minimum and maximum number of trees planted by the farmers practicing and not practicing agroforestry. The average, maximum and minimum number of trees for farmers practicing agroforestry was 62.9, 238 and 23 trees/ha, and 10.36, 3 and 19 trees /ha for those not practicing agroforestry respectively. Generally these are the multipurpose trees and shrubs deliberately intended for production of timber, poles, fuelwood, fodder and food/fruits and

provide shade, restore soil fertility, cut down soil erosion and improve the microclimate by reducing temperature extremes.

Table 7: Number of trees planted by farmers in the study area

Village	Farmers	Number of trees planted (ha^{-1})		
		Average	Minimum	Maximum
Ubiri	Practicing agroforestry	43.05	30	69
	Not practicing agroforestry	11.77	3	19
Ngulwi	Practicing agroforestry	74.24	23	210
	Not practicing agroforestry	9.82	5	14
Soni	Practicing agroforestry	95.36	29	238
	Not practicing agroforestry	7.28	3	10
Shashui	Practicing agroforestry	47.53	31	79
	Not practicing agroforestry	12.07	4	18

Most trees and shrubs were planted along the farm boundaries rather than contour lines. To the majority (80%) this makes a considerable sense from the point of view that planting trees on the boundaries causes less competition with crops. To some farmers the interval between trees was too wide to effectively support the intended goal of controlling soil erosion. Furthermore, few households had trees mainly *Leucaena leucocephala* meant for soil fertility restoration in their farm plots and of which also were very few in numbers. The reason given during focus group discussions was that these trees do not perform well in the study area. Most of the trees were therefore planted to save other purposes including food, fodder, timber, firewood, poles and other building materials and cut down soil erosion. According to Kerkhof (1990) and SECAP (1991) some of the trees and shrubs introduced into the study area like *Leucaena leucocephala*, *Leucaena diversifolia, Calliandra callothyrsus, Stylocenthus spp. and Desmodium spp.* for soil fertility

improvement performed poorly due to edaphic and climatic factors. Therefore farmers have found difficult to establish.

The fruit trees including mangoes, avocado, peaches, oranges, lemons, pawpaws, loquat etc to mention a few provided farmers with fruits for consumption and cash income from sale of the surplus. Through pruning of the trees and shrubs also farmers get firewood and building materials and fodder for livestock. Results from the focus group discussion have shown that, on average a household needed up to 4 head loads of firewood per week.

More than one third (38%) of farmers were obtaining firewood from trees planted on their farms, implying that to this group of farmers the agroforestry systems had enough trees to meet the household's annual demand for firewood. Majority of them were from Soni and Shashui villages with trees planted before SECAP under indigenous agroforestry systems. Forty five percent (45%) of the farmers were depending both on trees planted on their farms and buying firewood from neighbours. This represents both farmers practicing and not practicing agroforestry whose systems were not supplying adequately annual firewood requirements. Majority of this group of farmers had trees planted during SECAP i.e. trees were below 20 years. The remaining 17% of the farmers were mainly buying firewood from the neighbours. This is the group of the farmers who were not practicing agroforestry.

Household cash income

Table 8 shows distribution of the household's annual net income for farmers practicing and not practicing agroforestry. The calculated net income reflects aggregated values of the effects of agroforestry to the households in the study area and thus its contribution to household income poverty reduction. Comparatively, the net income for farmers practicing agroforestry was significantly different ($P<0.05$) from those not practicing agroforestry. On average, farmers practicing agroforestry had higher net income of Tshs 664,992 compared to Tshs 547,608 for those not practicing. The calculated income per capita (average household size is 6.6 persons) was Tshs 100,756 and Tshs 82,971 for farmers practicing and not practicing agroforestry respectively.

Therefore, considering the observed average farm size of 3.1 ha, a farmer practicing agroforestry was earning up to Tshs 214,513 ha^{-1} compared to Tshs 182,536 ha^{-1} for those not practicing. This implies that farmers practicing agroforestry are better off than those not practicing. They have relatively higher incomes that could help solve many of their daily socio-economic problems and therefore contributing more to household income poverty reduction than those not practicing agroforestry. However, the reported income from farmers practicing agroforestry was different from that observed by Moshi (1997) in the west Usambaras home gardens who reported a total income of Tshs 495, 091 yearly from 1.28 ha, which is equivalent to Tshs 386,789 per hectare, and the income per capita of Tshs 56,260 (average household size of 8.8 persons).

Table 8: The household's annual net income

Village	Household's annual net income (Tshs)	
	Farmers practicing agroforestry	Farmers not practicing agroforestry
Ubiri	723,628	553,069
Ngulwi	715,359	696,535
Soni	588,780	516,479
Shashui	632,201	424,350
Average	664,992	547,608

The study also found that an overwhelming majority (90%) of the surveyed farmers were merely depending on agroforestry as the main source of income. Based on these findings it can be argued that, the per capita income of Tshs 100,756 for farmers practicing agroforestry is more than three times lower than the average national per capita income for rural areas which is Tshs 314,016 (URT, 2007). For that reason farmers in the study area are still living in abject poverty spending less than US$ 0.50 on consumption a day i.e. Tshs 276 or US$ 0.28. This suggests that, despite the relatively higher contribution shown by agroforestry to household income poverty reduction, the production level and net income is generally low and therefore more efforts and strategies are

needed towards improving the systems' productivity otherwise poverty will still remain a problem in this area.

Farmers were asked to say whether the income was satisfactory to most of the household requirements where as 85% said not satisfactory, 13.6% was satisfactory to some extent and only two farmers (1.4%) said was very satisfactory. This implies that majority do not get enough income to meet most of their daily family requirements. Most of the incomes although not enough has been to the majority (80%) spend in basic needs, (16%) school fees and health services and (4%) hired labour and purchase agricultural inputs.

Factors Influencing Household's Net Income from the Agroforestry Systems

Table 9 presents the results of the regression model of the factors that were thought to account for more of the variations in the household's net income from agroforestry systems. Therefore the predictors, that is, farm size, household size, number of trees planted, number of livestock kept, and varieties of crops grown and cost of farm production were regressed against the household's net income. From the regression analysis, it was observed that the mentioned factors somehow explained the household's level of net income from the agroforestry systems because none of their standard coefficients was equal to zero. The regression model explained 71% of the variations in the factors affecting the household's net income as indicated by the R^2 (Table 9). Results further show that three of the six predictors included in the analysis, that is, the household size, number of trees planted and the annual cost of the household's farm production were statistically significant ($P<0.01$). This implies that the three predictors had an impact on the household's net income in the study area than others. Increase in size of these predictors brought about an increase in the household's annual net income at magnitudes indicated by their respective coefficients, and thus contributing to poverty alleviation.

Production cost was the highest predictor of the household's net income (β value of 0.475 with unstandardized regression coefficient (B) of 1.179) while number of trees planted the second predictor (β = 0.350 with B = 238.479) and household size the third predictor (β = 0.201 with B =

21365.228) (Table 19). The other predictors were not statistically significant in influencing the household's net income (P<0.05). Observations have shown that net income improved with increasing the household's size of the number of people who could actively participate into farming activities. Therefore farmers could improve production at low costs since they had sufficient and timely available labour thus, no need for hiring.

Table 9: Regression results of the factors influencing the household's net income

Predictor	Standardized coefficients (β)	Unstandardized coefficients (B)	(Std. Error)	Significant t	Significant P
Constant		209595.970	93368.536	2.245	.027
Farm size	-.095	-15478.966	10859.337	-1.425	.157
H/hold size	.201	21365.228	6925.839	3.085	.003**
No. of trees	.350	238.479	49.99	4.775	.000**
No of livestock					
1. Cows	-.125	-18475.335	10334.087	-1.788	.076
2. Goats	.034	3716.634	7663.969	.485	.629
3. Sheep	-.037	-4629.223	8306.512	-.557	.578
4. Chicken	.023	794.272	2266.059	.351	.727
5. Ducks	-.024	-8058.559	21895.952	-.368	.713
Crop varieties	.082	15520.541	13037.613	1.190	.236
Production cost	.475	1.179	.174	6.767	.000**

R^2 = 0.7082

Adjusted R^2 = 0.6515

** = Significant at P<0.01

The household's annual net income improved significantly with increasing number of trees in the farm plots implying that individual households, which had many tree species and shrubs, had higher net incomes. However, observations have shown that farmers with many agroforestry trees and /or shrubs had higher income because instead of buying fodder, firewood, timber and other construction materials from neighbours could obtain them directly from the agroforestry systems thus save money. They could also obtain income from sale of the surplus fruits from the agroforestry system(s). The trees also helped to provide shade to some crops including coffee and cut off soil erosion thus contribute to improving productivity of the agroforestry systems.

Results in Table 9 further show that the farm size and the number of cows, sheep and ducks kept influenced the household's annual net income negatively, and were not found statistically significant. This implies that as the number of these animals increased, there was a decrease in the household's net income. However, further observations showed that majority of the farmers had a problem of insufficient fodder production from the agroforestry systems. Therefore, including other associated costs of the livestock inputs; increase in number of the livestock's decreases the net income, as there were added costs of buying fodder and other inputs and since majority could not afford then the livestock were poorly fed thus low production as well as net income. In addition, there was a negative influence of the farm sizes to the net income probably because productivity of the farming systems was depending mostly on how best the systems were managed than their sizes. A farmer with a well-planed and managed agroforestry system could have higher yield regardless of the farm size given that there is a good management systems.

The varieties of the agricultural crops grown under the agroforestry systems and the number of livestock kept like goats and chicken had positive influence on the household's annual net income although they were not statistically significant. This implies that, farmers with many varieties of crops associated with the agroforestry trees and /or shrubs had more yields and net income than others. Goats and chicken also contribute to the net income probably because they require less initial capital and management costs. For example, management of chicken in the study area was basically through free-range system.

Conclusions and recommendations

From this study it can be concluded that the level of the household's farm production and net income is greater among farmers practicing agroforestry than those who were not practicing, implying that, agroforestry is significantly contributing to increased yields and income and thus income poverty reduction at household level. The trees and crops into such systems produce both food for subsistence and cash, fodder for the livestock, and reduce the problem of soil degradation and water quality and quantity while solving the problem of energy crisis. The livestock are mostly stall-fed and contribute to the household's nutrition and income through sale of their products like milk, eggs and meat. In order to improve productivity and sustainability of the agroforestry systems in Lushoto District and contribute to income poverty reduction, there is need for the government to promote efficient use of the farm inputs and labour along with policies, which harness market incentives is a prerequisite. Improvement of the market opportunities and extension services will also motivate farmers to invest in crop production and thus improve the management and production at large. Overall, the present findings on poverty reduction were only based on the household's level of production and income from the agroforestry systems. Therefore, to get a wider and clear picture of the poverty level in the study area, an assessment of the contribution of both farm and off-farm activities to the household's income is recommended.

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