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Full Length Research Paper

Impact of farm size and distance of home garden from water sources on farmers' choices of crops

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Backyard (home garden) agroforestry practice is most popular in the northern part of the country. This backyard agroforestry is practiced as a mixture of crops (vegetables, herbs) and trees (fruits and fodder trees) to provide diversified products to the cultivators. This study found over 40 species of plants maintained in home garden of the study area. Furthermore, agroforestry practice in backyard has a crucial role in the improvement of livelihoods to small scale farmers in the study area through direct subsistence production, indirect subsistence production (such as foods, fuel wood, fodder and shade to the cultivators) and income generation. Furthermore, it has helped to conserve many species of plants in a small areas with providing diversify needs to the farmers. However, we found that availability of water has significantly affected the home garden plant species diversity (t-test, n = 13, p < 0.05). Additionally, there is a high correlation between the diversity of vegetables (leafy, fruit and root and tuber crops, spice and herbs in combination) kept in backyards and availability of water (Number of plant species = 6.11767 (± 0.14790) -0.27023 (± 0.01349) distance from the river r^2 = 0.9733, $F_{1, 11}$ = 401.1 (P < 0.001) planting trees provide rural households with wood products for own consumption as well for sale and play role in decreasing soil degradation. Furthermore, our findings also suggest that households consider a number of attributes in making decision to backyard agroforestry practice. These results can be used by policy makers to promote home garden agroforestry practice in the study area by creating conducive water supply and considering households' backyard size and roofing system.

Key words: Agroforestry, home garden, backyard, Ethiopia, Tigray.

INTRODUCTION

Agroforestry is a new science for an old practice. And in Ethiopia it has been traditionally practiced since time immemorial by villagers on farm lands, grazing grounds, on farm house (such as home garden), as a wind break and shelter belt etc. But the scientific principles of agroforestry have been given due consideration only in recent years (Bashir et al., 2006). Agroforestry is a collective name for land use systems in which woody perennials are grown in association with herbaceous plants in a spatial arrangement, or/and in a rotation where there is usually both ecological and economic interactions between the trees and other components of the system (Lundgren and Raintree, 1982; Tewari, 1995). Furthermore, Daizy et al. (2008) strengthen this definition stating agroforestry practice as a dynamic, ecologically based natural resources management system through integration of trees in farmlands, rangeland, which diversifies and sustains production for increased social, economic and environmental benefits.

In principle agroforestry is an integrated approach of using interactive benefits by combining agriculture and

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forestry technologies to create more diverse, productive, profitable, healthy and sustainable land use system. Agroforestry just like in other parts of the world is an age-old practice in Ethiopia. However, the scientific study in the country is limited (Kindeya, 2004).

Globally there have been a lot of studies conducted based on remote sensing and GIS generated data. these research out puts indicated that Over 1 billion hectares (about 43%) of agricultural land have more than 10% tree cover, and these areas are home to almost a third of the 1.8 billion people who live on agricultural land (Zomer et al., 2009; World Agroforestry Centre, 2009) and indeed, trees on farms are now seen as one of the most promising means known to better adapt farming systems to climate change, and to absorb carbon dioxide in the battle to moderate global warming worldwide (World Agroforestry Centre, 2009).

But now there is a dire need for a series of much more detailed analyses that provide a better understanding of where people plant trees, why they keep them and how they use them and the devising strategies they have developed over the years. Furthermore, improving knowledge of farmer's motivation and strategies for agroforestry practice is equally important to the facts aforementioned

The main aim of this paper is, therefore to investigate home garden plant species composition, and to find out the impact of farm size and distance of home garden from water sources on farmers' choices of crops that they grown in Hiwane, southern part of Tigray.

MATERIALS AND METHODS

Description of the study site

Ethiopia is categorized into eighteen Major Agro-ecological Zones (MAEZ) and forty nine Sub-agro Ecological Zones (SAEZ) (MoA, 1998). Out of these, Tigray region is known to comprise seven of the Major Agro-ecological Zones (*MAEZ*) of Ethiopia: such as A1 (arid hot to very hot lowland plains), Sm2 (sub-moist tepid to cool mid-highlands), M2 (moist tepid to cool mid-lands), M1 (moist hot to warm lowlands), Sm1 (sub-moist hot to warm lowlands), Sm3 (sub-moist cold to very cold sub-afroalpine to alpine and Sa1 (semi-arid hot to warm lowlands). Owing to their highly diversified nature in terms of type and number, various horticultural crops are adapted to all of these agro-ecological zones in Tigray.

This study was conducted in Hintalo Wejerat district (Figure 1) which is one of the 36 districts of Tigray regional state, Northern Ethiopia. It has tepid sub humid agro ecology and it divided into 20 'Tabiyas' (Peasant Associations), among which Hiwane is one. Hiwane is further divided into 4 'kushets' (sub Peasant Association).

Data collection

Various tools of participatory data collection methods were followed to gather field data. An opinion of individual farmers as well as groups regarding home garden practices was collected from formal and informal discussions held during December, 2010 and May to July, 2011. A checklist was used to conduct guided discussion and a field visual observation of the surroundings study area was made. Farmers were selected using a systematic random sampling method from the lists available in the respective peasant associations and were interviewed using semi structured questionnaires.

Different literatures were reviewed to identify plant names after vernacular names of plants are recorded in a checklist in the study site. Field observation was done to see the existing situation and cross check people's opinion with real field condition. This was done in transect walk of the study area following the main Addis Ababa road that cross the town (Appendix 1 for the transect line). Furthermore, a comparative study was conducted using the river system verses households with no access to the river water which passes through the city.

Data analysis

All data collected during interview or/and guided filed observation (appendix 3) were subjected to statistical analysis. Analysis of variance was used ANOVA was used to check if the plant diversity has differ in home gardens in the study area. Furthermore, t-test was used to check whether availability of water has significantly affected the home garden plant species

RESULTS AND DISCUSSION

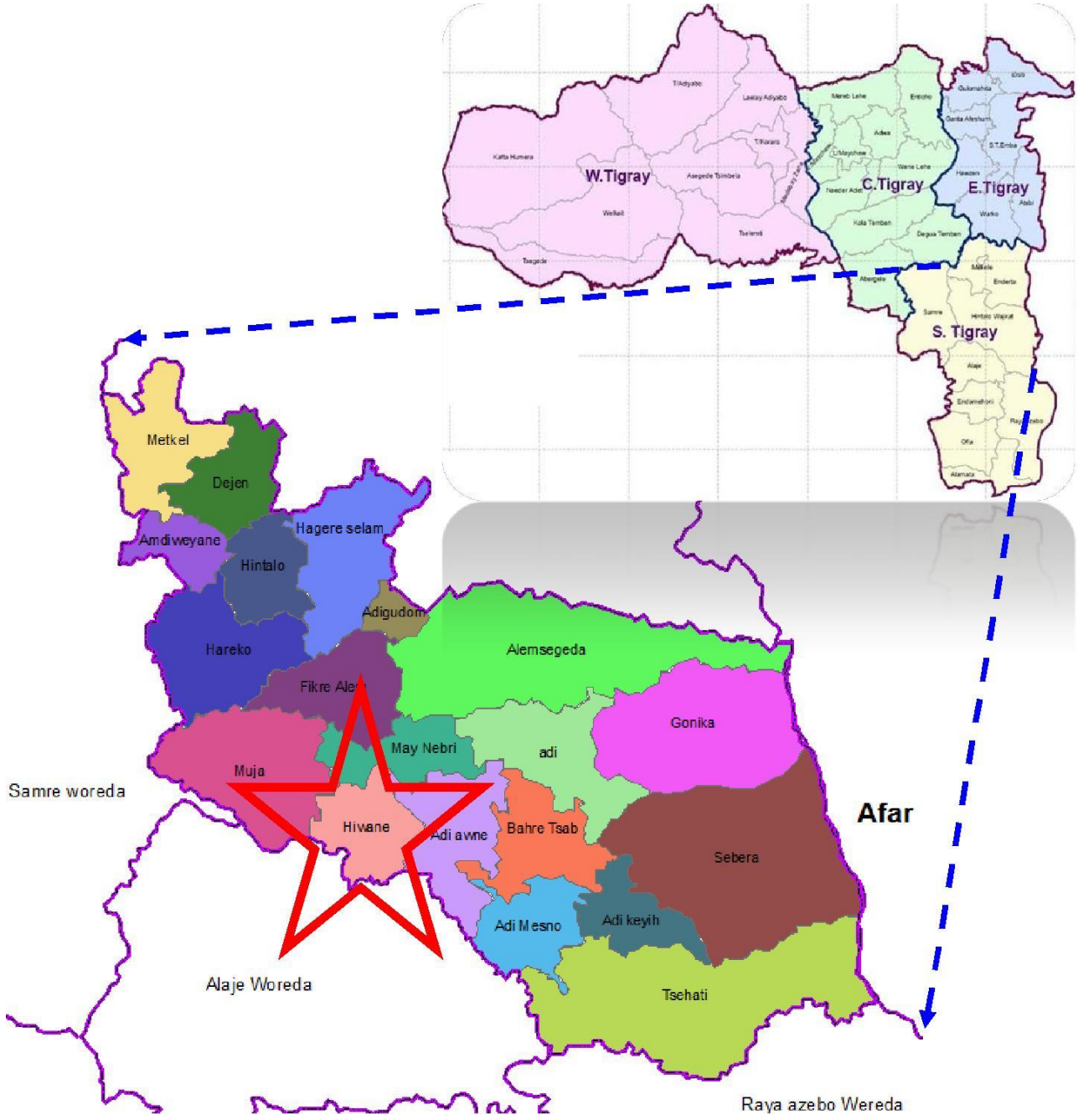
Home garden (back yards) coverage

Home garden literally means the 'backyard farm' while at the same time indicating the closeness of the cultivation plot to the house. The most common vernacular equivalent for the term backyard (home garden) is "dhri-bet". Common locations for gardens in relation to the house in Tigray are backyards, front yards, side-yards and those that almost encircle the house. In the study area, people maintain home garden in different size. The average size of the home gardens were reported to be ranging from about 500 m^2 to more than 2,500 m^2 (a quarter of a hectare), but in extreme cases, home gardens as small as 20 m^2 and as large as 10,000 m^2 have been reported in the study area. Larger home gardens, approaching the upper limit, are most frequent in households where the home garden is the only cultivated land available to stallholder farmers. When crop composition is considered, the home gardens are typically of the mixed type.

Plant species composition in backyards in Hiwane

A total of over 40 plant species were recorded in home garden in the study area (Appendix 2). These species falls into the categories of vegetables, fruit trees, fodder trees and cereals etc. Home garden plant composition were found to be dominated by vegetables (44%) followed by fruit trees (27%) and the least represented plant species in home garden of the study area are stimulants like coffee and chat (about 2%).

Despite the variation from cultivation plots of farmers', backyards collectively maintain a larger proportion of useful plant species. This diversity can be seen under



FigureFigure**1.**Map 1ofMapTigrayof (Top)Tigrayand(Top)HintalobyWejeratzone, HintaloDistrictwithWejeratthe20District'Tabiyas'with(Bottom)the 20hiwane'Tabiyas'indicated(Bottom)incircled by a star on the

map of and Hintalo Hiwane district. indicated in circled by a star on the map of Hintalo district

five main categories of backyard plant species namely:

(1) live fence species, (2) Vegetables (leafy, fruit and root and tuber crops) (3) Spices and herbs (Table 1) (4) Perennial fruit and fodder plants (Table 2) (5) Cereals like Barely, wheat, chickpea, lentil.

The backyard agroforestry practice plays great economic role for the small farm holders in the study area for subsistence production or through income generation. The subsistence could of course be either through direct subsistence production or indirect subsistence production (Table 3 for the plants that are reported to have such a purpose). Direct subsistence production manifested by plant species producing edible fruits (like papaya, guava, mango, avocado, orange, citron and *Opuntia)* or edible

Table 1. Vegetables and spice crops growing in backyards in the study area.

Vernacular name	Botanical name
Aba'ekhe	*Trigonella foenum-grecum*
Ades	*Myrtus cuminis*
Berbere	*Capsicum annuum*
Chena adam	*Ruta chalepensis*
Dinish	*Solanum tuberosum*
Duba	*Cucurbita pepo*
Gomen	*Beta vulgaris* var. *cicla*
Hamli adri	*Brassica nigra* var. *Abyssinica*
Hamli gurmba	*Brassica carinata*
Karot	*Daucus carota*
Keyih Shigurti	*Allium ascalonicum*
Komedere	*Lycopersicum esculentum*
Kosta	*Brassica oleoracea*
Selata	*Lactuca sativum*
Seseg	*Ocimum basilicum*
Tsaeda shigurti	*Allium sativum*

Table 2. Perennial fruit and fodder plants found in the study area.

Vernacular name	Botanical name
Apple	*Malus sylvestris*
Aranshii	*Citrus auranticum*
Avocado	*Persea americana*
Awhi	*Cordia africana*
Bokre-lomin	*Citurs aurantifolia*
Gesho	*Rhamnus prunoides*
Giba	*Zizizphus spina-christi*
Kundo berbere	*Schinus molle*
Lomin	*Citrus limonia*
Lucinia	*Luceana leucocerphala*
Mango	*Mangifera indica*
Menderin	*Citrus reticulata*
Muz(Bananna)	*Musa* spp.
Papaya	*Carica papaya*
Qulqual bahri	*Opuntia ficus-indica*
Trungii	*Citrus medica*
Zieytun	*Pisdium guajava*

tree fruits produce (like *Zizizphus spina-christi*, *Cordia africana* etc.) which became available at different time of year. On the other hand, an indirect subsistence production is manifested by provision of fodder, shade and fence for live stock. *Equilaptus globulus, Acacia etbaica*, *Euphorbia* spp*., Opuntia ficus-indica* etc fall into this category. Furthermore, the indirect substance production is manifested in that some of the trees provide ecological significance/function/ like soil improvement and conservation which increase food production (forexample , *Agave* spp. *Rumex steudelii)*. What is more, plants in home garden provide another indirect subsistence production in the provision of medicine (leading to a better health care system and people will be secured and be able to work and produce more food (example plants like *Lepidium sativum, Myrtus cuminis* and *Silene macrselen* etc.).

Meanwhile, backyard agroforestry practice play great economic role through their significant contribution in purchasing power (for income generation) when sold for

Table 3. Indirect subsistence production (plants with ecological significance and indirect subsistence to the smallholder farmers in the study area)

Vernacular name	Botanical name
Azmir	*Bersama abyssinica*
Engule	*Solanum incanum*
Entati'e	*Linum usitatissimum*
Ere	*Aloe calidophylla*
Guliie	*Ricinus communis*
Hamba-hambo	*Cassia arereh*
Natran	*Artemisia afra*
Qolqual	*Euphorbia* spp.
Saero saero	*Silene macroselen*
Semhal	*Mentha longifolia*
Seraw	*Acacia etbaica*
Shemboba'eta	*Rumex steudelii*
Shinfa'e	*Lepidium sativum*

Figure 2. Partial Views of Wheat, Lettuce and Hop (Gesho) Agroforestry in Home Garden

Figure 3. A woman selling *Zizizphus spina-christi* fruit (left and middle) girls (right) selling *Ruta chalepensis* at a local market in the study area.

Figure 4. Shembaeta *(Rumex steudelii)* planted at water canals to protect bank erosion (left and middle) and *Agave* spp. and *Opuntia ficus-indica* on the outer margins as reinforcements for fences used in backyard (right).

construction material, as fuel wood (*E. globulus*, *Acacia etbaica*), sold as food (*Citrus* spp, *Carica papaya, Psidium guajava*, *Opuntia ficus-indica*, *Z. spina-christi*, *Persea americana, Mangifera indica*) or sold for making drink like *Rhamnus prunoides* (leaves are sold commercially for making beer and "siwa" (local drink)

Comparison of plants species composition in the study area

Availability of water has significantly affected the home garden plant species diversity (t-test, $n = 13$, $p < 0.05$). Furthermore, there is a high correlation between the diversity of Vegetables (leafy, fruit and root and tuber crops, spice and herbs in combination) kept in backyards and availability of water (Number of plant species = 6.11767 (± 0.14790) -0.27023(± 0.01349) distance from the river $r^2 = 0.9733$, $F_{1, 11} = 401.1$ $P < 0.001$) but statistically non significant correlation relation between perennial fruit and fodder plants. Similarly the live fence species showed statistically non significant correlation with availability of water. On the other hand the diversity of cereals like Barely, Wheat, Chickpea and Lentil kept in backyard are highly correlated to size of backyard/home garden that the small farmer own.

Smallholder farmers in the study area have different prefernces: farmers away from the river (but who have

access to water from the reserviour prefered ceareals in rotation with leafy vegetables. However, farmers with small sized homegarden prefered leafy vegetables to cereal because they gain a good produce from small plot compared to the produce they obatain from cereals. Besides, they claimed that they would rather go for leafy vegetables to pernial tree fruits (like manogo, avocado and citrus spp. because the short time produce/economic value. This is inline with results of other researchers (Badege and Abdu, 2003; Zenebe, 2007).

Conclusion

The study indicated that high biodiversity of herbs and plants with medical values are maintained in the backyards. There is clear evidence that backyard agroforestry (home garden) can enhance food security and improve rural livelihoods. The study clearly indicated that backyard agroforestry practice in the study area can possibly increase soil fertility and crop yields by conserving soil and reduce soil erosion. Home gardens practice in the study area serve critical functions in fulfilling community and household needs ranging from food provision and food security to augmenting the family nutritional status, ensuring primary healthcare, income generation and fulfilling other utility functions. Its importance for in situ conservation of the valuable agro-biodiversity and the sustainability of the surrounding ecosystem is well appreciated. Furthermore, home gardening can help maintain the biodiversity of important plant species around the homesteads. Therefore, there is dire need to the consideration and integration of home garden agroforestry practice with urgency to:

(i) Identify potentials for the introduction and expansion of vegetables which can grow in small area with enhanced water harvesting techniques (like roof water harvesting during rainy season)

(ii) Identify appropriate intervention strategies for the introduction and expansion of home garden; and lobby the government to consider the options and make intensive interventions in home gardening.

(iii) Look for means to encourage women to plant and maintain herbal plants of medical importance and for spices and thereby maintaining biodiversity.

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Appendix 1. Transect walk study used in the study area(red arrow indicates the way to Addis Ababa and rectangular white colored lines transect lines considered 500 m far from each other two along the river side and other two transects on the opposite side of the river that pass through Hiwane.

Appendix 2. List of some of the plant species kept in home garden of the study site with some specific purpose given by the respondents.

Vernacular name	Botanical name	Purpose
Berbere	*Capsicum annuum*	Culinary value/spice
Dinish	*Solanum tuberosum*	Edible tuber
Kosta	*Brassica oleoracea*	Food (for sale and/or own consumption)
Gomen	*Beta vulgaris* var. *cicla*	Food(for own consumption)
Komedere	*Lycopersicum esculentum*	Culinary value
Hamli adri	*Brassica nigra* var. *abyssinica*	Food(for own consumption)
Hamli gurba	*Brassica carinata*	Food (for own consumption)
Duba	*Cucurbita pepo*	Food (for own consumption)
Selata	*Lactuca sativum*	Food (for sale and/or own consumption)
Tsaeda shigurti	*Allium sativum*	Culinary value
Keyih Shigurti	*Allium ascalonicum*	Culinary value
Karot	*Daucus carota*	Edible root/for sale
Seseg	*Ocimum basilicum*	Spice/culinary value
Abaekhe	*Trigonella foenum-grecum*	Medicinal value when used with honey/ culinary value
Chena adam	*Ruta chalepensis*	Spice/culinary value
Ades	*Myrtus cuminis*	Stimulant
Buna tekli	*Coffea arabica*	Stimulant/for sale
Avocado	*Persea americana*	Edible fruit

Awhi	*Cordia africana*	Edible fruit/shade/fuel wood and construction material
Giba	*Zizizphus spina-christi*	Edible fruit/live fence/fuel wood and medicinal value
Zeitun	*Psidium guajava*	Fruit for sale or own consumption
Menderin	*Citrus reticulata*	Fruit for sale or own consumption
Papaya	*Carica papaya*	Fruit for sale or own consumption
Apple	*Malus sylvestris*	Fruit for sale or own consumption
Mango	*Mangifera indica*	Fruit for sale or own consumption
Trungi	*Citrus medica*	Fruit for sale or own consumption
Aranshi	*Citrus auranticum*	Fruit for sale or own consumption
Lomin	*Citrus limonia*	Fruit for sale or own consumption
Bokri lomin	*Citurs aurantifolia*	Fruit for sale or own consumption
Muz	*Musa* spp.	Edible fruit (for subsistence consumption)
Gesho	*Rhamnus prinoides*	To prepare local drink/for sale or own consumption
Qulqual bahri	*Opuntia ficus-indica*	Edible fruit for sale /live fence
Lucinia	*Luceana leucocerphala*	Fodder
Sesbania	*Sesbania sesban*	Fodder and live fence/shade
Kundo berbere	*Schinus molle*	Shade, live fence medicinal value
Kelamitos	*Equilaptus globulus*	Shade, fuel wood, construction material and medicinal value
Shemboba'eta	*Rumex steudelii*	Protect bank erosion, medicinal value
Shinfa'e	*Lepidium sativum*	Medicinal value
Semhal	*Mentha longifolia*	Religious ritual/ medicinal value
Engule	*Solanum incanum*	Medicinal value(for livestock)
Qolqual	*Euphorbia* spp.	Live fence/construction material
Natran	*Arthemisia afra*	Religious ritual/medicinal value
Azmir	*Bersama abyssinica*	Culinary value/spice
Chena adam	*Ruta chalepesis* var.*tenuifolia*	Medicinal value/spice culinary value
Ades	*Myrtus cuminis*	Medicinal value
Ere	*Aloe calidophylla*	Soil conservation/protect bank erosion and live fence
Saero saero	*Silene macrselen*	Medicinal value/repellent for serpent(snakes)
Hamba-hambo	*Cassia arereh*	Fuel wood
Guliie	*Racinus communis*	Lubricant for local oven(mitad) and live fence when mixed with other trees
Entati'e	*Linum usitatissimum*	Culinary value/spices and as lubricant
Barely, wheat, sorghum, chickpea, Maize		Food, make drink (esp.sorghum and maize), culinary value (esp.chickpea)

Appendix 3. Some photos during Interview with some of the respondent.