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Agroforestry Practice and its Socioeconomic Benefits in Eastern Ethiopia

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ABSTRACT

Background: Agroforestry is a kind of land use system that has been practiced since long in many parts of the world. Even if agroforestry is contributing a lot for the farmers, no study has been conducted which acknowledges the socio-economic importance of agroforestry practices in Harari regional state. Therefore, this may create a problem to expand and adapt the practices to another area for the cope and mitigate climate changes and achieve food security.

Methods: The study used descriptive statistics to analyze the data. It ascertained the role of agroforestry practices in Harari regional state. A sample of 350 farmers was interviewed and selected using two-stage random sampling techniques.

Result: The results showed that 100% of the sample respondents practiced agroforestry as a land use for income source, shade, soil improvement, fodder, firewood, construction material, medicinal purposes etc. The components of the agroforestry system adopted by the local community were pulse, root, cereal crops and vegetables. *Khat, Eritia, Acacia, Cordial, Zeziphus* were the fodder species used. 78.57% of the respondents used a stallfeeding technique to feed their animals. The respondents obtained annual income of 32,199.16 Ethiopian birrs on average. In general, the agroforestry system helps the local communities to diversify their income, fulfill animal feed and cope with and mitigate climate change. To sustain the local people with the climate change, decision-makers and researchers should give more attention to the preferred agroforestry species.

Key words: Agroforestry components, Feeding techniques, Fodder species, Preferred species, Species importance.

JEL codes: O13, Q01, Q12, Q18, Q23

INTRODUCTION

Agroforestry is a kind of land use system that has been practiced since long in many parts of the world (Garrett, 1997; Regmi and Garforth, 2010). It encompasses a very large and diverse set of practices ranging from croplands to complex forest production (Freese *et al*., 2011; Santos *et al*., 2019). Agroforestry is practiced by more than 1.2 billion people worldwide (Jamnadass *et al*., 2013) and represents around 1000 million hectares (Nair *et al*., 2009). An integrated crop-livestock-forestry system has good potential for enhancing income and food security (Basamba *et al*., 2012; Koussihouèdé *et al*., 2019; Magalhães *et al*., 2018; Pandit *et al*., 2019; Quintos *et al*., 2017). Agroforestry is offering the potential for enhancing farm production, household income and welfare (Dhakal *et al*., 2012; Hong *et al*., 2019; Linger, 2014). It offers farmers an array of economic opportunities, social and environmental benefits (Adhikari *et al*., 2019; Basamba *et al*., 2012; Djanibekov *et al*., 2016; Freese *et al*., 2011; Gold and Garrett, 2009; ICRAF, 2006; Koussihouèdé *et al*., 2019; Magalhães *et al*., 2018; Nuberg *et al*., 2009; Stoian *et al*., 2012; Zamora and Udawatta, 2016) and it is a solution for the dual climate and food security challenges (Adhikari *et al*., 2019; Albrecht and Kandji, 2003; De Stefano and Jacobson; 2018, Dinesh *et al*., 2017; Meragiaw, 2017; Reppin *et al*., 2019; Sharma *et al*., 2016).

Furthermore, it is the most important sources of timber and fuel wood for household consumption and income generation (Dubois, 2011; Fahmi *et al*., 2018; Holt and Murphy, 2018; Niasse, 2011; Quandt *et al*., 2017; Thorlakson and Neufeldt, 2012). Besides, the non-timber forest products (NTFP) of the agroforestry system contributes to the rural economy (Iponga *et al*., 2018; Tripathi *et al*., 2019). At the same time, it reduces the conflicts between farming, livestock and forestry interests in the same land (Dhakal *et al*., 2012; Linger, 2014). Moreover, it protects soil erosion, improving air, water and biodiversity (Freese *et al*., 2011; Gold and Garrett, 2009; Koussihouèdé *et al*., 2019; Magalhães *et al*., 2018; Zamora and Udawatta, 2016). Therefore, a variety of agroforestry technologies is finding enormous applications in African countries (Basamba *et al*., 2012).

In Ethiopia, there are different agroforestry systems such asfor example fruit tree-based agroforestry practices (Biazin *et al*., 2018; Bishaw and Abdulkadir, 2012), cash crop-based alley cropping and woodlots at the edge of the crop fields (Bishaw and Abdelkadir, 2003). Harari national

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regional state is characterized by high population pressure and a scarcity of arable and grazing land (Headey *et al*., 2014). High population pressure and land deficit are narrowing farmers' decisions (Jayne *et al*., 2014). To minimize the problems of high population pressure and land deficit, the farmers have been introduced high-value tree-based farming systems (Biazin *et al*., 2018; Okoh, 2016). The tree-based farming systems is used to diversify income and minimize the impact of climate change.

Even if agroforestry is contributing a lot for the farmers, no study has been conducted which acknowledges the socio-economic importance of agroforestry practices in Harari regional state. Therefore, this may create a problem to expand and adapt the practices to another area for the cope and mitigate climate changes and achieve food security. Previous studies were conducted on agroforestry technology evaluation (Mekonnen *et al*., 2009; Yadessa *et al*., 2001) and agroforestry practices (Abebe, 2005). Other studies determined the role of agroforestry for biodiversity conservation (Bhagwat *et al*., 2008; Jose, 2012; McNeely and Schroth; 2006) and farmers' perception on agroforestry practices (Meijer *et al*., 2015). Gebru *et al*. (2019) were conducted a study to determined factors affecting the adoption of Agroforestry practice, whereas Garrett (1997) assessed the role of agroforestry for production and farmland conservation. Furthermore, (Albrecht and Kandji, 2003; Thorlakson and Neufeldt, 2012) analyzed the role of agroforestry for socio-cultural and carbon sequestration. Therefore, none of the above studies assessed the socio-economic importance of agroforestry practices for the local communities in the Harari region. This study, therefore, intended to determine the socio-economic benefits of agroforestry practices. The components of agroforestry practices and their income contributions were also determined. The importance of agroforestry species and species preference by the respondents was also assessed.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Harari People's National Regional State. The Region is located within 9°11′49″ - 9° 24′42″N Latitude and 42°03′30″ - 42°16′24″E Longitude and the altitude of the Region ranges between 1552 and 1957 m above sea level. It is one of the nine regional states of Ethiopia. It has the smallest land area and population size (183,415) with an estimated density of 589.05 people per square kilometer. In the region, 46,169 households were counted with an average of 3.9 persons in a household (FDRE, 2018). The area is generally known for its cash crop production, food crop deficit and uneven rainfall distribution.

Sampling techniques, types of data and data collection methods

A two-stage sampling technique was used to select the respondents. In the first stage, 3 *kebeles*[1] were selected purposively from 17 *kebeles* based on the agroforestry practices. In the second stage, 350 sample household were selected randomly. Accordingly, 160, 150 and 40 household were selected based on proportion to population from *Aberkele*, *Gelma Shira* and *Sofi kebeles*, respectively. Primary data on the type of crop, trees species grown and preferred, fodder species and income obtained from the components of agroforestry were collected from the sample respondents using face to face interview. Transect walk was made to visit households' agroforestry fields to determine the vegetation composition to check the correctness of the data collected from the sample respondent. Secondary data was collected from published and unpublished materials.

Data analysis

The data were analyzed using descriptive statistics such as mean, standard deviation, frequency distribution and percentage.

RESULTS AND DISCUSSION

Components of agroforestry practice and their use

Agroforestry has been practiced by all the sample respondents. The type of agroforestry practiced in the study area was Alley cropping (*Khat* crop with cereal crops plus scattered trees). This is consistence with the components of agroforestry listed in Mosquera-Losada *et al*. (2009). The components of agroforestry practiced were cereal crops, pulse, root crops, cereal with vegetables. The result is consistent with the finding of Gebrehiwot (2003). The respondents used different agroforestry components based on their preference (Table 1). These types of agroforestry systems were used to cope with and mitigate the effect of climate shocks. The result is consistent with the finding of Meragiaw (2017). For example, the eastern part of Ethiopia was severely affected by climate change-driven drought in 2016. However, due to the agroforestry practices, the study area was not affected by the drought driven by climate change. Therefore, currently, the government and nongovernment organizations are investing a lot of money to integrate crop-livestock-tree as a Agrosilvopastoral agroforestry model in the same land.

As present in the Table 2, agroforestry and its components were used for animal feeds in the study area. 35.5% of the respondents used crop residue plus weeds/ grasses for animal feeding. In addition, fodder trees were also a source of feed especially during the drought season (Table 2). The result is consistent with the finding of Arefaine and (Azage, 2015; Dargo and Haftay, 2015; Seidavi *et al*., 2019). About 78.57%, 20.57% and 0.86% of the respondents were used stall feeding, both stall feeding and free grazing and free grazing techniques to feed their animals respectively. This is consistent with the study made by (Sodarak *et al*., 2005). About 99.14% of the respondents

[1]*Kebele* is the smallest administrative hierarchy in Ethiopia.

reported that the reason for their stall feeding was a shortage of grazing land.

The study is identified the fodder species used by the respondents (Table 3). Accordingly, 21.43% of the respondents reported that *Khat* also *Cordia plus Erythrina* fodder species were used to feed their animals. Whereas 8.57% of the respondents reported that *Khat*, *Cordia* and *acacia* species were used for their animal. All the respondents have used *Khat* species as a cash crop and feed source. Next, to *Khat*, the most frequently mentioned species is Acacia. About 72.57% of the respondents reported that these species were used for their animal feed source especially during the dry season. About 78% and 22% of the sampled household reported that the niche of the fodder species was scattered on the crop field and border of crop field, respectively. In addition to these fodder species, the households used green grass and weeds as a source of feeds during the summer season (June to September).

Uses of agroforestry species

As presents in Table 4, agroforestry species provided different benefits for the household For instance, *Casmoria* used as a source of cash and shade benefits. *Cordial Africana* and *Acacia Albedia* also provided timber, soil fertility improvement, fodder and shade benefits. In addition, the respondents were also used Olia Africana for a hand tool, farm implement, fuelwood, fumigation, shade purposes *etc*.

In addition, agroforestry species like Vernonia is used for traditional medicinal purposes and utensils cleaning (Table 5). The *Juniperus, Guajava, Anona* were also used among

Table 1: The components of agroforestry practice (N=350).

Components	Frequency	Per cent
Cereal crops (Maize and sorghum)	24	6.9
Pulse crops (Groundnut)	15	4.3
Root crops (Sweet potato, cassava)	11	3.1
Livestock (Cattle, goat, sheep, donkeys, hens)	5	1.4
Cereal crops and vegetables	12	3.4
Cereal crops, livestock, root crops, vegetables and pulse crops	1	0.3
Cereal crops and livestock	282	80.6
Total	350	100

Table 2: Different sources of animal feeds (N=350).

Feed sources	Frequency	Per cent
Crop residue and weeds/grasses	124	35.43
crop residue, elephant grass, concentrate and fodder trees	71	20.29
crop residue, concentrate and fodder trees	90	25.71
Crop residue, elephant grass, fodder trees and weeds	65	18.57
Total	350	100

Table 3: Fodder species used (N=350).

Fodder species	Frequency	Per cent
Khat and *Acacia*	40	11.43
Khat and *Cordia*	47	13.43
Khat, Cordia and *Acacia*	30	8.57
Khat, Cordia, Acacia and *Vernonia*	45	12.86
Khat, Eritiam, Acacia and *Cordia*	52	14.86
Khat, Cordia and *Erythrina*	75	21.43
Khat, Eritiam, Acacia, Cordia and *Zeziphus*	61	17.43
Total	350	100

Table 4: Uses of agroforestry species (N=350).

Species	Uses	Frequency	Per cent
Casmoria, Guajava and anona	Shade/Cash	350/216	100/61.72
Cordial Africana	Timber, soil fertility improvement, fodder, shade farm implement	350	100
Acacia albedia	Soil fertility improvement, fodder, fuel-wood, charcoal, shade	350	100
Olia Africana	Hand tool, farm implement, fuel-wood and charcoal, fumigation, shade construction material	350	100

Table 5: Uses of agroforestry species (N=350).

Species	Uses	Frequency	Per cent
Juniperus	Construction material, Timber, Shade	350	100
Vernonia	Medicinal values, washing utensils	350	100
Eritia, vernonia and zeziphus	Fruit, Shade, Fodder	350	100

Table 6: Uses of Agroforestry species (N=350).

Species	Uses	Frequency	Per cent
Khat	Cash income and construction material/fodder	350/332	100/94.9
Croton macrostachys	Soil fertility improvement, fodder, shade, firewood	272	77.7
Casmoria and	Cash income and shade	171	48.9
Mango,	Shade and cash income	251	71.7
Papaya and Banana	Fruit and cash income	171	48.9

Table 7: Income contributions of agroforestry practices in Birr (N=350).

Income sources	Minimum	Maximum	Mean	Std. deviation
Sorghum	0	10000	3500.57	3109.69
Maize	0	4300	1618.39	1608.26
Khat	3520	40000	17187.46	7760.25
Coffee	0	10000	182.14	920.87
Mango	0	4000	112.57	395.35
Guajava	0	1200	73.86	206.58
Casmoria	0	600	119.43	147.31
Ox	0	20000	5879.43	7688.49
Donkey	0	1500	260.30	430.30
Goat	0	6000	1928.00	1910.03
Hen	0	1000	296.34	285.73
Sheep	0	600	1.71	32.07
Total annual income			32,199.16	

Table 8: Tree species preferred by the respondents (N=350).

Species	Preference in rank	Frequency	Per cent
Khat	1	350	100
Acacia albida	2	236	67.43
Cordial	3	239	68.29

Source: Own data.

others for shade purpose especially when the respondents are chewing *Khat*.

Khat has been exported to Arab countries and used as a source of hard currency for the country. Even if the *Khat* has a negative effect on health, the local communities were unable to survive without the production of *Khat*. This is because the area is known by high population size and farmland deficit. Therefore, it is unable to feed the people by producing other crop like maize, sorghum, barley *etc*. The area is also known in producing and consuming fruits like mango, casmoria, papaya and banana. These species use for different purposes as specified in (Table 6).

Agroforestry practices and its income contribution

The components of agroforestry provided a different amount of income for the respondents (Table 7). The maximum and minimum average income was obtained from *Khat* and sheep production *i.e.* 17,187.46 and 1.71 *birrs* per year, respectively. The study shows that the livelihood of the respondents was depended on the production of *Khat*. But, other components of agroforestry have a significant contribution to the livelihood status of the respondents. This is consistent with (Namwata *et al*., 2012; Regmi, 2003).

Tree species preference and its management

The livelihood of the study area depends on agroforestry practice mainly by producing *Khat*. It is the first preferred species by the respondents for income source and chewing purposes (Table 8). In addition, *Acacia Albida* and *Cordial* were the second and third most frequently mentioned and prefered species in the area. This is because the species gave a different benefit for the respondents as it is discused in subsection 3.2.

Table 9: Participation of family members on agroforestry management (N=350).

Participation	Frequency			
	Men	Women	Children	Per cent
Cultivating land	21	10	38	6.57
Rearing livestock	21	68	20	10.38
Planting and managing trees and shrubs	20	105	40	15.71
Managing crops (Cultivating, sowing, weeding, harvesting, threshing)	20	73	40	12.67
All (Cultivating land, rearing livestock, planting and managing trees and shrubs and managing crops (Cultivating, sowing, weeding, harvesting, threshing)	268	94	212	54.67

In agroforestry management, the family members played an important role. For instance, the men participated in cultivating the land, rearing livestock, managing trees and crops. Table 9 presents about 55% of the family members was involved in cultivated land, rearing livestock, planting and managing trees and crops. In addition to household tasks and petty trades, women also participated in agroforestry management.

CONCLUSION AND RECOMMENDATION

The study identified the importance and preferred agroforestry species. Agrosilvopastoral is practicing by the sample respondents. The agroforestry practices were used as a source of cash income, shade, farm tools, soil improvement, fodder, firewood, construction material and medicinal purposes. *Khat*, Eritia, *Acacia, Cordial, Zeziphus* were the most fodder species used in the area. In addition to petty trade and households chores, females participated in agroforestry management. *Khat* is the first preferred species in the study area followed by *Acacia Albida* and *Cordial* species. This is because the area is known by population pressure and land deficit. Therefore, the respondents earned more benefits by producing *Khat* from a small plot of land. That is the livelihood of the local communities depends on the production of *Khat*. In general, agroforestry practices help the local communities to diversify their income and cope and mitigate the impact of climate change.

Based on the findings of this study, the following recommendations are forwarded to sustain the livelihood of the people. First, agroforestry practice provided different benefits for the local communities, so that the government and other concerned stakeholders should make the necessary interventions to expand the practices to drought areas with similar characteristics. Secondly, the government should encourage the resettlement policy in the highly populated and farm land-deficit areas. Thirdly, when designing the agroforestry management policy, the government should give more attention to the most preferred agroforestry species to improve the income of the local people. Finally, training should be given to the members of the family about the importance of the division of labor to minimize women burden.

Conflict of interest

All authors declare that they have no conflicts of interest.

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