Article DOI: https://doi.org/10.37284/eajfa.5.1.681

East African Journal of Forestry & Agroforestry
eajfa.eanso.org
Volume5, Issue 1, 2022
Print ISSN: 2707-4315 | Online ISSN: 2707-4323
Title DOI: https://doi.org/10.37284/2707-4323

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Agroforestry and Household Food Security Status among Small-Scale Farmers in Kubo South and Samburu Wards of Kwale County, Kenya

Bernard Owuor Odit[1], Hilda Ong'ayo[2] & Daniel Nyamai[3]*

[1] Kenya Forestry Research Institute, P. O. Box 5199, Kisumu, Kenya.
[2] Pwani University, P. O. Box 195 - 80108, Kilifi, Kenya.
[3] Rongo University, Kenya P. O. Box 103 – 40404, Rongo, Kenya.
[*] Author for Correspondence ORCID: https://orcid.org/0000-0001-5766-3946; email: benodit912@gmail.com.

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

Date Published:

24 May 2022

Keywords:

Agroforestry, Households, Food Security.

ABSTRACT

This study investigated the contributions of agroforestry to household food security in Kwale County. The study objectives were to determine the status of agroforestry, the status of household food security, and the relationship between agroforestry and household food security. Descriptive cross-sectional survey research design was applied, with multistage sampling procedure, which comprised of purposive and random sampling for selection of the study sites and respondents from different villages in Kubo south and Samburu wards, Kwale County. The sample size for the study comprised of 270 smallholders and 10 key informants. The study used a combination of instruments, namely, structured questionnaires, focus group discussions, observation, and interview schedules. Descriptive statistics and regression analysis were used to test relationship between agroforestry and household food security. The study found that 14.1 % were food secure, 2.96 % households mildly food insecure, 54.81 % were moderately food insecure and 27.41 % were severely food insecure. Majority of farmers practice agrosilvopastoral system of agroforestry due to the multiplicity of social, economic, and environmental benefits they derive from it. The results further indicated that challenges facing agroforestry farmers include poor access to credit, inadequate extension services, wildlife destruction, pests and diseases, and inadequate markets for agroforestry products. The study concludes that there is high level of food insecurity among smallholder farmers and recommends concerted efforts by county and national governments to intensify the practice of agroforestry, improvement of access to inputs for agroforestry, allocate more land for agroforestry practice, proper tree species selection, adoption of best agroforestry practices based on research, and suitable tree planting arrangements for improved household food security.

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

APA CITATION

Odit, B. O., Ong'ayo, H., & Nyamai, D. (2022). Agroforestry and Household Food Security Status among Small-Scale Farmers in Kubo South and Samburu Wards of Kwale County, Kenya *East African Journal of Forestry and Agroforestry*, *5*(1), 59-75. https://doi.org/10.37284/eajfa.5.1.681

CHICAGO CITATION

Odit, Bernard Owuor., Hilda Ong'ayo and Daniel Nyamai. 2022. "Agroforestry and Household Food Security Status among Small-Scale Farmers in Kubo South and Samburu Wards of Kwale County, Kenya". *East African Journal of Forestry and Agroforestry* 5 (1), 59-75. https://doi.org/10.37284/eajfa.5.1.681

HARVARD CITATION

Odit, B. O., Ong'ayo, H., & Nyamai, D. (2022), "Agroforestry and Household Food Security Status among Small-Scale Farmers in Kubo South and Samburu Wards of Kwale County, Kenya", *East African Journal of Forestry and Agroforestry*, 5(1), pp. 59-75. doi: 10.37284/eajfa.5.1.681.

IEEE CITATION

B. O. Odit, H. Ong'ayo, & D. Nyamai, "Agroforestry and Household Food Security Status among Small-Scale Farmers in Kubo South and Samburu Wards of Kwale County, Kenya", *EAJFA*, vol. 5, no. 1, pp. 59-75, May. 2022.

MLA CITATION

Odit, Bernard Owuor., Hilda Ong'ayo & Daniel Nyamai. "Agroforestry and Household Food Security Status among Small-Scale Farmers in Kubo South and Samburu Wards of Kwale County, Kenya". *East African Journal of Forestry and Agroforestry*, Vol. 5, no. 1, May. 2022, pp. 59-75, doi:10.37284/eajfa.5.1.681

INTRODUCTION

Agroforestry has been promoted in Africa as a low input land use practice to facilitate farmers improve soil fertility, increase income, and enhance food security (Oduol *et al*. 2006). Since the early 1990s, the World Agroforestry Centre and its partners in Eastern and Southern Africa have developed a wide range of technologies for improving soil fertility and significantly boost crop yields by providing high returns on labour and land (Makumba *et al.*, 2007). According to Thangata *et al*. (2002), agroforestry protects farmers against socio-economic shocks due to the diversification of species and products that ensure that risks are spread and farmers are well cushioned in case of extreme events. Over 480,000 farmers are practicing agroforestry in Southern Africa and have achieved various benefits including increases in crop yields, income, savings, wealth creation, and soil improvement (ICRAF, 2007). Those who practice agroforestry have had an increase in maize yields from 1 t/ha to 3 t/ha (Garitty *et al.*, 2010). Agroforestry also plays an important role of increasing the yields of vegetables and fruit, and also provide varied and nutritionally balanced diets rather than calories alone (Susila *et al.*, 2012). The agroforestry sector is often impeded by legal policy and institutional arrangements, leading to its environmental benefits being unrewarded and investments discouraged (FAO, 2013). Most agricultural policies in Africa have more support for external than internal technologies, inputs, and practices (FAO, 2001). Globally, more than 1.3 billion people practice agroforestry ranging from linear planting, mixed, home gardens, hedges, boundary planting, woodlots, and alley planting (Dawson *et al.*, 2013). Over the years agroforestry system have evolved and become more complex and some examples include Cacao system in West Africa, the rotational woodlots in Kenya, home gardens in Mt Kilimanjaro area of Tanzania, and the parkland system of the Sahel (Beddington *et al*., 2012; de Foresta *et al*., 2013).

In Kenya, ICRAF and other development partners have made concerted efforts to promote agroforestry in different parts of the country through partnership with Government and community-based organizations as a solution to increasing agricultural food productivity for food insecurity and environmental degradation (Place, 2009). The Kenya Agricultural Research Institute (KARI) conducted several agroforestry experiments with

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

farmers on the adoption of agroforestry technologies from 1988 to 1992, to determine their suitability for the coastal lowlands. These adoption studies showed that the intercropping system had an advantage for smallholder farmers (ILCA, 1994). In a study conducted by Jamnadass *et al*. (2013), in Kenya and Malawi, exotic and indigenous fruits dominate the rural agroforestry systems. Agroforestry contributes to household food security directly by providing edible products and indirectly through fodder, soil fertility improvement, and conducive micro-climate for crop productivity (Maliki *et al*., 2012). In North Lampung, Sumatra, home gardens, averaging 0.75 ha, contain as many as 21 tree species excluding the understory component (Tukan et al., 2002). In a survey conducted around eastern Mount Kenya, approximately 200 different tree species were identified on farms (Oginosako *et al.*, 2003). In one central market in Ghana, it was found that there are approximately 700 people involved in the forest product trade on a full-time basis and that trading was a dominant economic activity in even the remotest villages of Southern Ghana (Weibe & Maxwell, 1998). Tropical home gardens and agroforests have shown to improve diversification and resulted in better food security for smallholder farmers and that research should be intensified on how such systems can be improved for better food security particularly in areas far from the markets (Hagos *et al.*, 2002; Michon & De Foresta, 1995; Kumar & Nair, 2004). Agricultural growth is very crucial for improving the living standards of the poor and alleviating poverty as this helps increase food productivity and income (Thirtle *et al.*, 2001). In this research, we sought to investigate the contribution of agroforestry to food security in Kwale County, a region which is relatively poor and has extremely low agricultural activities.

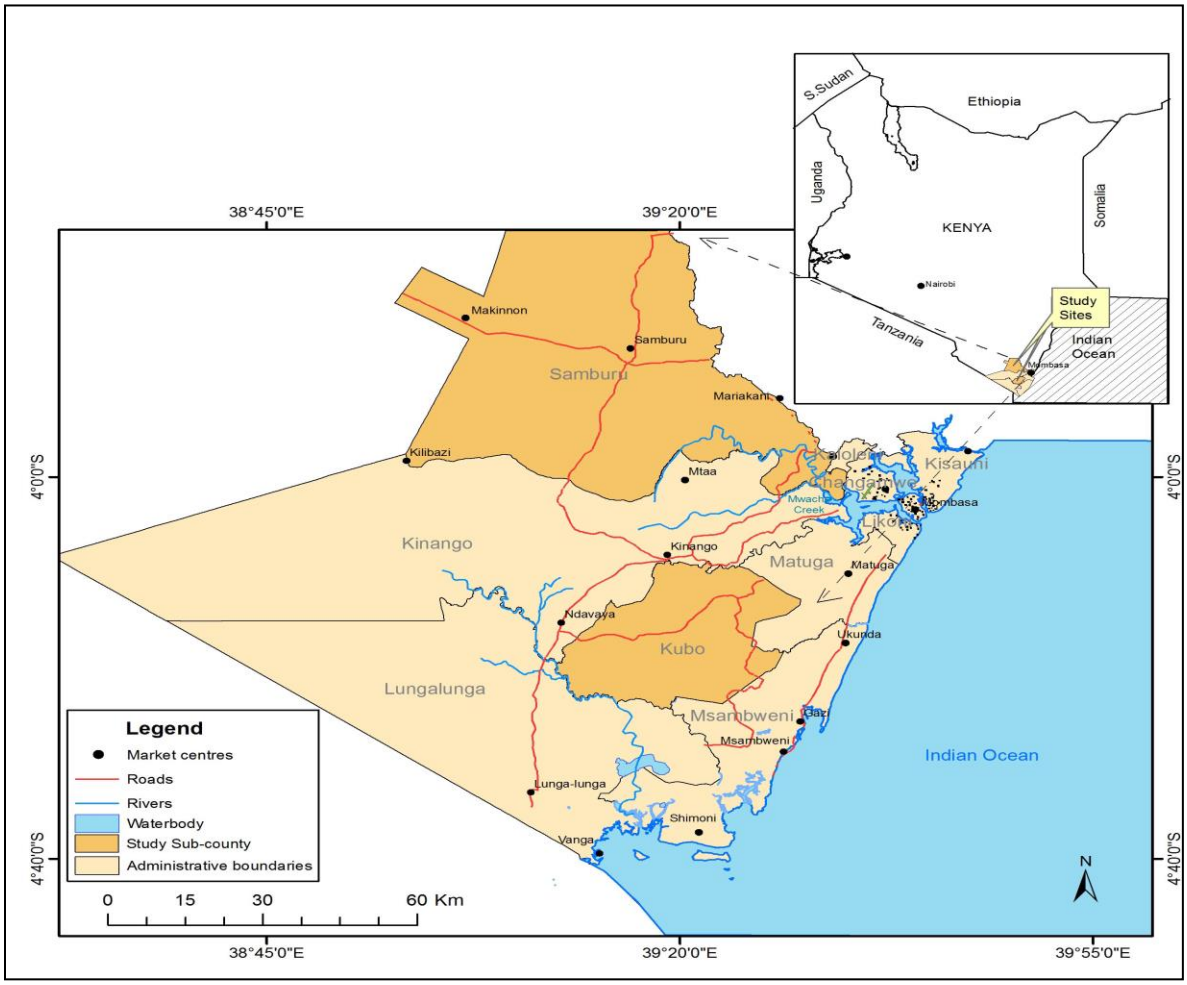
MATERIAL AND METHODS

Study Site

The research on which this paper was conducted was in Kwale County. Kwale County has 122,047 households out of which 74.9 % live below poverty line. The county receives rainfall ranging from 400 to 1600 mm per annum (Kwale County Government, 2013). Agriculture is the main economic activity for the households with most farmers practicing mixed farming.

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

Figure 1: Map of study area



Research Design

The study used descriptive survey design with the total target population of 122,047 households (Kwale County Government, 2013). The sample frame population of 10,513 households, was drawn from smallholder farmers in Kubo South and Samburu Wards, Kwale County where 400 small scale farmers were selected using simple random sampling and 10 key informants randomly selected from ministry of agriculture, Kenya Forestry Service, Kenya Agricultural and Livestock Research Organizations, County government staff, staff of NGOs, community leaders and community-based organizations.

RESULTS

Demographic Profile of Households

The socio-economic characteristics of the household heads as respondents that were studied included age, gender, education level, and household and farm size. These characteristics were chosen in order to get an overview of the composition and status of the respondents for the purpose of drawing implication in relation to agroforestry practices and household food security in the study area. The results are as shown in *Table 1*.

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

Table 1: Demographic characteristics of the respondents

Demographics	Variables	Frequency (n=270)	Percentage
Gender	Female	60	22
	Male	210	78
Age	18-35 years	41	15
	36-60 years	167	62
	Above 60	62	23
Level of education	No Formal education	50	18.5
	Primary	137	50.7
	Secondary	73	27.1
	Tertiary	10	3.7
Household size	4-7 members	112	41.4
	8-12 members	99	36.6
	12+	46	17.2
Farm size	less than 1 acre	5	1.9
	1-3 acre	14	5.2
	4-6 acres	76	28.2
	6 acres+	175	64.7

The results in *Table 1* shows that among the 270 respondents interviewed, majority (62%) were within the age bracket of 36 to 60 with 23% and 15% being above 60 years and between ages 15-35 years respectively. This implies that generally there were very few respondents within the youth age bracket of 15 to 35 years. The findings are in line with those of FAO (2015) who asserted that rural youths have developed negative perception on agriculture hindering them from fully becoming active in farming. Study finding in table 1 show that more than three quarters (78%) of the respondents were male while the rest (22%) were female. This implies that probably there were more male-headed households who participated in agroforestry than female-headed households. It could also be due to patriarchal nature of most African societies. The findings agree with those of Hildreth (2008) which also showed that males were major players in the practice of agroforestry. Similarly, (Herrero *et al.*, 2014) agreed with survey results and concluded that that, in some African societies it is a taboo for women to plant trees creating the perception that planting and managing trees in agroforestry is the responsibility of the masculine gender. These cultural beliefs may hinder the adoption of agroforestry practices. A study by Kiptot and Franzel (2012) asserted that, women are actively involved in agroforestry although the level of participation is low relative to men. The majority (50.74 %) of the respondents had acquired primary level of education with very few (3.7%) having attained college level education (*Table 1*).

According to Oino and Mugure (2013)household size is an influencing factor to practice agroforestry in that when the family size is big, members tend to plant more trees because the need of tree products are higher and also labour is available. Results of the study further show that majority (64.7%) of the households had land sizes of six acres and above with a very negligible (1.9%) percentage having land size less than 1 acre. The farmers' decision to practice agroforestry and what to grow on farms for food for their household and the market is dependent on how much land is owned by the farmers. This result is supported by studies conducted in Nyeri, which revealed that farmers with relatively larger parcels of land allocated more land for tree planting (Nyambari, 2008; Mugure, et al., 2013). Studies done in Zambia also support the claim that farmers with more land are likely to adopt agroforestry technology and can afford to

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

experiment with new technology and still have land to spare for food production without compromising on food production and food security (Waha *et al.*, 2016). However, the results contradict those from Kakamega which indicate that majority of farmers have planted trees despite their small holdings Similar studies by Keil et al., (2005) noted that most agroforestry farmers were willing to expand their farm size but cited limited labour as constraining factors to expansion

Household Food Security among Agroforestry Farmers

The first objective of the study was to determine the status of food security among smallholder agroforestry farmers. Household food security in this context is the ability of the household to produce food from agroforestry practices in enough quality and quantity all year round. Three dimensions of food security were considered namely food availability, food access and food stability. The direct and indirect contributions to household food security were considered in the study. The findings and discussions are presented in the following subsections.

Table 2: Household Food Security Status

Household Food Security Status	**Percent % (n=270)**	
Description	**Yes**	**No**
Worry that HH will not have food	79.63(215)	20.37(55)
Lack of resources to buy preferred food	79.63(215)	20.37(55)
Did you have to eat limited food due to lack of resources	74.72(201)	25.28(69)
Eat food did not want due to lack of resources	75.46(203)	24.54(67)
Small meal due to lack of resources	60.67(162)	39.33(108)
Fewer meals in a day due to lack of resources	55.60(149)	44.40(121)
Complete lack of food due to lack of resources	25.94(73)	74.06(197)
Sleeping hungry due lack of food	8.96(24)	91.04(246)
Having to go whole day and night without food	3.02(9)	96.98(261)

Table 2 represents the responses of the households on the various food insecurity domains. Majority (79.63%) of the respondents' worry that they will not have food for their household and lack resources to buy preferred food during the past 30 days. A majority of respondents accounting for (79.63 %) lacked resources to buy preferred food. (74.72 %) had to eat limited food due to lack of resources. Additionally, (60.67 %) had to eat small meals due to lack of resources. About half of the households had to eat fewer meals due to lack of resources (55.60 %), whereas only 3.02 % had to go without food all day and night. Lastly, 8.96 % had to sleep hungry due to lack of food. The study findings indicate that majority of the households were not able to provide enough food for their families' all year round, and had to reduce the quantities and number of meals they eat for their food production to last the whole year hence. This implies that the agroforestry systems practiced by the households do not adequately support food security either directly for food or indirectly through income to purchase food. The other possibility is that the food production and income from agroforestry practices is not enough to meet the demand of the households due to high dependency ratio and low productivity due to low application of agroforestry technology. Further analysis was done on the findings on status of food security to categorize households in the levels of food insecurity according to international practice. The results of the categorization of the smallholder farmers into food insecurity levels are as shown in *Table 3*.

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

Table 3: Categories of food insecurity

Household food insecurity level(categories)	Households	Percent (%)
1. Food-secure	40	14.81
2. Mildly food-insecure	8	2.96
3. Moderately food-insecure	148	54.81
4. Severely food-insecure	74	27.41
Total	**270**	**100.00**

The results in *Table 3* Show that households were placed into 4 categories as per the procedure applied by FAO and USAID for determining household food insecurity among households (Coates, 2013). The responses indicated that majority of the households are moderately food-insecure (54.8%), followed by severely food –insecure households at (27.4%). less than 20% were food –secure (14.8%) and mildly food-insecure households accounted for (3.0%).

Only 14.8 % had access to enough quality and quantity of food all year round with the rest being at different levels of food insecurity. This implies that households practicing agroforestry in the coast region of Kenya are not producing adequate food from their farms and have to meet their food needs through diversification of farming activities and also through venturing into various off-farm activities to meet the short fall. The inability to produce enough food is probably due to the poor soil conditions, erratic and unreliable rainfall, and destruction by animals. The results of the study are consistent with other studies which indicate that farmers have to diversify their income sources by engaging in different activities both on-farm and off-farm (Silvestri *et al.*, 2015). Focus group discussions and key informant interviews with different stakeholders revealed that households have not had good crop years over the last two years due to drought and unreliable rainfall, inadequate extension services, and lack of credit to access farm inputs which have all worked in combination to reduce farm productivity and hence contribute to food insecurity for the majority of the households. This study is consistent with studies conducted in India using the HFIAS tool and found that 77 % of the households were food insecure and also further indicated that households were spending up to 50 % of their income on food (Chinnakali et al., 2014). The results of this study are also comparable to those conducted in Sabah, Malaysia that applied the HFIAS tool and indicated that 64.7 % of the households were food insecure (Farhadian et al., 2015).The food insecurity among the households was found to be mainly due to inadequate funds and other resources to purchase food. Silvestri et al. (2015) studied the link between agriculture and food security among farming households in selected sites in Kenya, Uganda and Tanzania and revealed that there is high food insecurity among the farming households, 62 % in Rakai (Uganda), 80 % in Lushoto (Tanzania) and 85 % in Wote (Kenya).

The Status of Agroforestry Practice among Smallholder Farmers

Objective two sought to establish the status of agroforestry practice among smallholder farmers. Respondents were asked questions on the purpose of the trees, acreage under tree, types of plants intercropped with trees and the average number of trees planted. The results are presented in the subsequent sub sections.

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

Table 4: Purposes of planting trees

Purpose of trees	No of respondents	Percent (%)
Commercial use/sale for income	593	33.1
Use as food	590	32.9
Domestic use	179	10
Seed production	128	7.1
Shade	73	4.1
Use as building materials	62	3.5
Fruits	49	2.7
Timber	29	1.6
Firewood	27	1.5
Poles	23	1.3
Windbreak	13	0.7
Medicinal	12	0.7
Boundary	6	0.3
Rain attraction	4	0.2
Bee foliage	2	0.1
Reduce soil erosion	1	0.1
Total	**1791**	**100**

The results in *Table 4* show that trees on the farms with commercial purpose scored the highest count 33.1%, food (32.9%), domestic use (10%), seeds production (7.1%), shade (4.1%), building materials (3.5%), fruits (2.7%), timber (1.6%) and firewood (1.5%). The results imply that there are diverse tree species being grown in the farms. Diversification of trees planted on the farms ensures continuous income streams and helps the framers spread the risks due to fluctuating markets and unpredictable weather conditions. The results of this study are in agreement with studies by Regmi (2003) and *Baul et al.* (2015), which revealed that trees grown through various agroforestry practices play vital roles in supporting households in many diverse ways, including provision of food, income, fuel wood, building materials, and fodder for livestock. The results of this study are also consistent with the results of a study by Gibreel (2013), who asserted that preferences in many small-scale agroforestry farmers on different tree species on farms are driven mainly by economic factors and less on environmental management. The results of this study are also in tandem with those of Nzilano (2013), in Tanzania on the choice of trees in agroforestry home gardens by households revealed

that majority of the farmers planted tree based on their economic benefits.

Status of Tree Growing and Acreage under Agroforestry

The researcher sought to establish the changes in tree growing over the last five years. The farmers were asked about the trends in tree growing in the area. The results are as presented in *Table 5* below:

Table 5: Trees status on the farm

Status	No of respondents	Percent (%)
Increasing	109	40.37
Reducing	161	59.63
Total	**270**	**100**

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

The results in *Table 5* show that the majority (59.6%) of the respondents indicated that trees within the farms were reducing while 40.4% of respondents stated that trees were increasing on the farms. The results imply that the tree cover in the study area is reducing and therefore the benefits that farmers obtain from the trees are shrinking hence need to intensify planting of trees for enhanced benefits. During the Focus Group discussions, farmers emphasized the role of markets and prices in determining which trees they grow. Fruit trees have always been planted as there is ready market and that they also provide the household with food while other trees such as *Bixa* and *Casuarina* has mainly been planted for commercial use and the land dedicated to the trees have been proportional to the market availability. Farmers also rationalize tree planting in response to the markets and plant more of a particular tree depending on the market availability. The reduction in the number of trees could probably be due to small land sizes that force the farmers to prioritize between planting crops and trees. The results of this study are in agreement with those of Hitchcock (2004), that indicated that food production among smallholders takes the highest priority and farmers allocated more land to food production with the remaining land allocated to commercial tree and crop production which is further scaled down when land becomes increasingly smaller. The results also concur with a study by LeRoy et.al (2017), that asserted that farmers preferred cutting down of old trees on their farms to give way to crop production as they were not able to get ready market for poles due to the slump in the tourism industry which have been major market sink for poles for construction of hotels.

Table 6: Mean acreage under different Agroforest systems and land tenure system

Agroforest systems practiced	Land tenure System	Mean	Std. Er	Std. Dev
Trees/crops	Private	3.71	0.286	0.756
	Communal	3.8	0.107	0.414
	Total	3.77	0.113	0.528
Trees/crops/livestock	Private	2.2	0.2	0.447
	Communal	1.7	0.153	0.483
	Total	1.87	0.133	0.516
Total	Private	3.08	0.288	0.996
	Communal	2.96	0.227	1.136
	Total	3	0.178	1.08

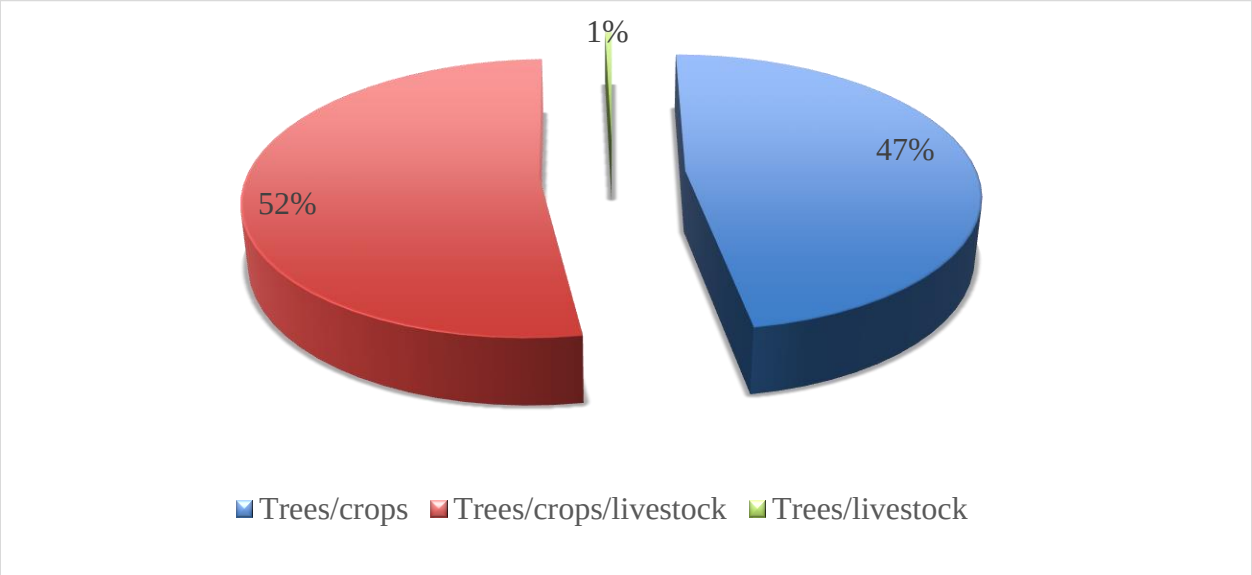
The results in *Table 6* indicate that the mean land size for private ownership was (3.71±0.286 acres) and for communal land tenure system was 3.80±0.107 for those who practiced tree and crops agroforest system. The respondents who practiced tree/crops/livestock had low size for private (2.20±0.200 acres) and in relation to communal land tenure system (1.70 ±0.153 acres) under the same agroforestry system. The results imply that there was more land allocated to agroforestry practice under the communal land tenure system than under private land tenure system. The results support studies by Quisumbing (2001) and Holden et al. (2009), which indicated that land tenure system is a critical determinant on adoption of agroforestry among rural households. However, a similar study by Mugure *et al.* (2013), in Busia County contradicts these results as it found that allocation of land by household head to the sons' hindered tree planting because trees claimed a huge portion of the land therefore reducing the land available for the planting trees.

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

Tree Planted Under Different Agroforestry Systems

In order to establish the average number of trees planted, farmers were asked the number of trees they plant under the different agroforestry systems. The results were as shown in Figure 2.

Figure 2: Trees planted on the farms under different agroforestry systems



The respondents indicated in *Figure 2* that the mean number of trees planted by the 128 (47.39%) respondents who practiced tree/crops agroforestry system were 92.25±15.878 trees while 141 (52.17%) respondents who practiced tree/crops/livestock agroforestry system were 67.31±9.133 trees. The results imply that majority of farmers prefer growing trees and crops alongside keeping livestock. The results are in agreement with studies done by Jerneck and Olsson (2014) showed that farmers plant more tree species on the farm as an insurance against uncertainty in climate and food shortage and to generate income to meet their domestic.

Income Under Agroforestry

The information from the respondents showed that majority of the farmers who practiced tree/crops mostly grew maize (56.2%), beans (18.8%) and cassava (16.1%) while those who practiced tree/crops and livestock also grow maize (69.3%), Cassava (17%) and Beans (5.9%) among other crops as shown in *Table 7.*

Table 7: Crops Grown under Agroforestry

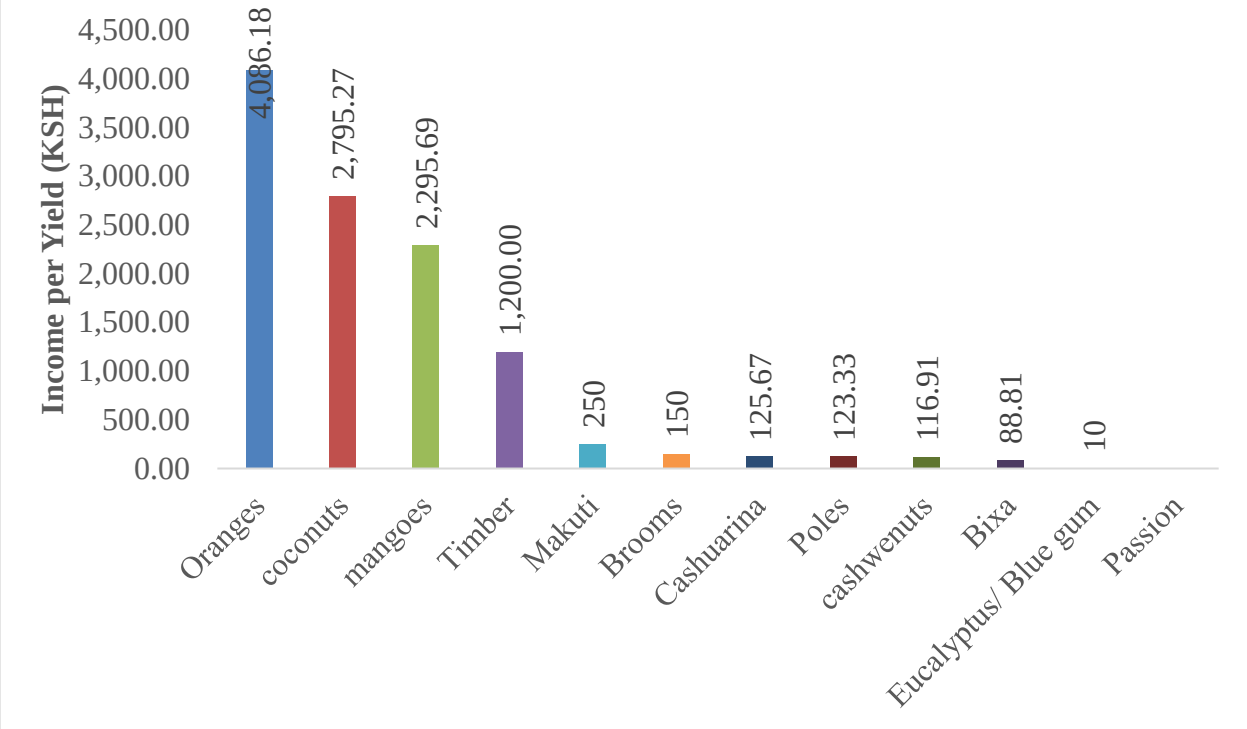
Agroforest systems	Different crops you grow N (%)						
	Maize	Cassava	Beans	Green gram	Bananas	Pawpaw	Cow Pease
Trees/crops	63(56.2)	18(16.1)	21(18.8)	6 (5.4)	2(1.8)	2 (1.8)	0 (0.0)
Trees/crops/livestock	106(69.3)	26 (17.0)	9 (5.9)	5 (3.3)	2(1.3)	1 (0.7)	4(2.6)

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

The findings depict that majority of the households grew different types of crops. The reason for the crop diversification could be to enhance the capacities of the households to cope with drought adversities. Further inquiry by the FGD revealed that in recent years, rainy seasons had become shorter and often unpredictable a situation that calls for diverse crop production mostly drought resistant crops. The results of this study support other studies by Zomer *et al.* (2014) and Coulibaly *et al.* (2015)

The results in *Figure 3* indicate that yield for oranges (Ksh 4,086) were highest followed by coconuts (Ksh 2,795), mangoes (Ksh 2,295) and Timber (1,200). Fruit trees generated more income followed by *makuti* and farmers responded by planting more fruit trees and *casuarina* to generate more income to meet their domestic demands such as food.

Figure 3: Income from Agro forestry products' yield



The results of the study is consistent with other studies that indicated that fruits provide farmers with income and also double up as food therefore enhancing the food security of the farmers (Oduol *et al*., 2006). The results also correspond to another study that showed that the markets for agroforestry products have been very unreliable and have affected what farmers can produce and sale to generate income (Lindell, 2010). Lindell (ibid) further add that through the markets, farmers have been able to exchange various agroforestry products for income that is then used to purchase food.

DISCUSSION

Land availability is crucial in the practice of agroforestry as it is one of the major factors of production. The land allocated to tree planting affects the quantities of food that farmers will produce and the higher the land allocated to tree planting the higher the food produced. The results of this study found that area of land allocated to agroforestry practices significantly affected household food security. The results are in agreement with studies conducted in Nyeri where

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

farmers with larger tracts of land allocated more land for tree planting (Nyambari, 2008). The results are also supported by studied done in Zambia where farmer with larger parcels of land were found to be more likely to adopt agroforestry technologies and were more food secure (Waha *et al.*, 2016). The results of this study are in agreement with other studies by Aidoo and Tuffour (2013) and FAO (2014), that asserted that land availability and the trees farmers grow on the farm play a major role in contributing to household food security.

Access to inputs such as high-quality seeds, technologies and seedlings is also important in the practice of agroforestry. Access to latest technologies in agroforestry is limited to few farmers who can afford to reach out for extension services through visits to government offices and use of modern technologies. The low adoption of agroforestry technologies by the rural households has exacerbated food insecurity in Kwale County. The results are in agreement with other findings that revealed that incentives given to farmers by providing fertilizers and pesticides motivates farmers and improves their farming practices and results in high yields therefore enhancing food security (Segnon et. al. 2015). When farmers realize the full potential of agroforestry and intensify on the planting of trees that improve soil fertility, they will reduce reliance on inorganic fertilizers.

Different trees provide different products at different times during the year therefore ensuring continuous streams of benefits to farmers all year round. Farmers plant different tree species for different purposes and adopt agroforestry technologies that give them the products that they desire. Majority of the farmers were found to plant trees for commercial purposes (33.1 %) and for food production (32.9 %). The results of the study are in agreement with other studies that showed that farmers plant trees that provide them with income, food, fodder, and wood for domestic and commercial uses (Regmi, 2003; Baul *et al.*, 2015; Gibreel, 2013).

Farmers apply different tree planting arrangements for different products in the practice of agroforestry. The different tree planting arrangements results in different products for different farmers depending on the local conditions. The results are supported by other studies that found that farmers adopt different tree planting configurations to maximize the interactions between crops, livestock and for maximization of beneficial interactions and minimization of negative interactions (Lasco *et al.*, 2016; Lewis, 2002).The farmers in Kwale have been practicing agroforestry for several decades and have been testing different technologies and adopting what works for them and reducing on the technologies that are less beneficial and changing their agroforestry practices depending on the market demand for different products. The case in point is the allocation of more land for planting trees for poles such as *casuarina* during the periods when the tourism industry is thriving to supply construction materials and cutting down the trees when there is a slump in tourism and allocating more land to crops and fruit trees to improve their food security situation.

Majority of farmers were found to prefer an agroforestry system that integrates trees crops and livestock (52.17%), trees/crops (47.39 %) and trees/livestock (0.44 %). The farmers prefer the agrosilvopastoral system as it provides a wide range of benefits all years round and greatly improving their food security situation. The results are in tandem with other studies conducted in Ethiopia and Tanzania that indicated that the agrosilvopastoral system is popular among farming communities especially when there is proper sequencing and integration of the different components to ensure optimal productivity (Lulandala, 2009).

RECOMMENDATION AND CONCLUSIONS

Majority of famers in Kubo South and Samburu wards practice some form of Agroforestry and are motivated by the various benefits they get including income, food, improvement of soil fertility, shade,

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

fodder for livestock during drought. There is high level of food insecurity among most of the rural households as a result of several factors that interact at household level to affect each household in a very unique way. Based on this research work, the central government, regional and key stakeholders must engage in order to enhance household food security programs, farmers to improve and diversify by planting different types of trees within their farms, more land allocated to tree plantation establishment and finally the planted trees must have positive effect on improving soil productivity as opposed to degradation.

ACKNOWLEDGMENT

I have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. First and foremost, let me that my Employer, Kenya Forestry Research Institute (KEFRI) for giving the opportunity to undertake the study. My supervisors, Dr. Hilda Ong'ayo and Professor Daniel Nyamai mentored and supervised me during the study diligently and with great devotion that made the study a success. The study would not have been possible without the financial support by the World Bank through the Kenya Coastal Development Project, which was implemented by Kenya Marine and Fisheries Research Institute in collaboration with other government agencies and non-Governmental agencies working in the coast Region of Kenya. I would like to express my special gratitude and thanks to Dr. Samson Okoth Ojunga of the Biometrics section for giving me such attention and time. My thanks and appreciations also go to my colleagues in KEFRI and the KCDP project for the great guidance and technical support in developing the project and people who have willingly helped me out with their abilities. My classmates, Masters in Environmental Studies (Community Development) Class and staff at Pwani University prepared a good foundation and learning environment for conducting the study and for this I thank them immensely both individually and collectively. May God bless you all.

REFERENCES

Aidoo, R. M., & Tuffour, T. (2013). Determinants of Household Food Security in the Sekyere-Afram Plains District of Ghana. *Presented at the Annual International Interdisciplinary Conference* on 24-26 April. Azores, Portugal.

Baul, T. K., Rahman, M. M., Moniruzzaman, M., & Nandi, R. (2015). Status, utilization, and conservation of agrobiodiversity in farms: a case study in the North-western region of Bangladesh. *International Journal of Biodiversity Science, Ecosystem Services & Management*, *11*(4), 318–329.

Beddington, J. R., Asaduzzaman, M., Clark, M. E., Bremauntz, A. F., Guillou, M. D., Howlett, D. J. B., Negra, C. (2012). What next for agriculture after Durban? *Science*, *335*(6066), 289–290.

Chinnakali, P., Upadhyay, R. P., Shokeen, D., Singh, K., Kaur, M., Singh, A. K., Pandav, C. S. (2014). Prevalence of household-level food insecurity and its determinants in an urban resettlement colony in north India. *Journal of Health, Population, and Nutrition*, *32*(2), 227.

Coates, J. (2013). Build it back better: Deconstructing food security for improved measurement and action. *Global Food Security*, *2*(3), 188–194.

Coulibaly, J. Y., Mango, J., Swamila, M., Tall, A., Kaur, H., & Hansen, J. (2015). What climate services do farmers and pastoralists need in Tanzania? Baseline study for the GFCS Adaptation Program in Africa. *CCAFS Working Paper no. 110*. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Dawson, I. K., Guariguata, M. R., Loo, J., Weber, J. C., Lengkeek, A., Bush, D., & Orwa, C. (2013).

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

What is the relevance of smallholders' agroforestry systems for conserving tropical tree species and genetic diversity in circasitum, in situ and ex situ settings? A review. *Biodiversity and Conservation*, *22*(2), 301–324.

de Foresta, H., Temu, A., Boulanger, D., Feuilly, H., & Gauthier, M. (2013). *Towards the assessment of trees outside forests: a thematic report prepared in the Framework of the Global Forest Resources Assessment 2010*. Rome, Italy: Food and Agriculture Organization of the United Nations. http:// www.fao.org/3/aq071e/aq071e01.pdf

FAO. (2001). *The State of Food Insecurity in the World 2001*. Rome, Italy: Food and Agriculture Organization of the United Nations. http://www.fao.org/docrep/003/y1500e/y1500e00.htm

FAO. (2013). *Advancing agroforestry on the policy agenda: a guide for decision makers*. Rome, Italy: Food and Agriculture Organization of the United Nations.

FAO. (2013). *The State of food Insecurity in the World, The Multiple Dimensions of Food Security*. Rome, Italy: Food and Agriculture Organization of the United Nations.

FAO. (2014). *State of the World's Forest genetic resources, Commission on genetic resources for food and agriculture*. Rome, Italy: Food and Agriculture Organization of the United Nations. http://www. fao.org/3/i3825e/i3825e.pdf

FAO. (2015). *Social Protection and Agriculture: Breaking the Cycle of Rural Poverty*. Rome, Italy: Food and Agriculture Organization of the United Nations.

Farhadian, A., Chan, V. S., Farhadian, H., & Farhadian, H. (2015). Addressing household food insecurity using the household food insecurity access scale (HFIAS) in a poor rural community in Sabah, Malaysia. *Int J Humanit Soc Sci Invent*, *4*(8), 89-100.

Garrity D.P., Akinnifesi FK, Ajayi OC, Sileshi GW, Mowo JG, Kalinganire A, Larwanou M, Bayala J. 2010. Evergreen Agriculture: a robust approach to sustainable food security in Africa. *Food Security* 2:197–214.

Gibreel, T. M. (2013). Crop commercialization and adoption of gum-arabic agroforestry and their effect on farming system in western Sudan. *Agroforestry Systems*, *87*(2), 311-318. https://doi.org/10.1007/s10457-012-9552-2

Hagos, F., Pender, J. & Gebreselassie, N. (2002). Land degradation and strategies for sustainable land management in the Ethiopian highlands: Tigray region. *Socio-economics and Policy Research Working Paper 25*. Nairobi, KE: International Livestock Research Institute.

Herrero, M. T., Notenbaert, A. M. O., Thornton, P. K., Pfeifer, C., Silvestri, S., Omolo, A., & Quiros, C. (2014). A framework for targeting and scaling-out interventions in agricultural systems. *CCAFS Working Paper*.

Hildreth, L. A. (2008). The economic impacts of agroforestry in the Northern Plains of China. *Agroforestry Systems*, *72*(2), 119–126.

Hitchcock, G. (2004). *Wildlife Is Our Gold: Political Ecology Of The Torassi River Borderland, Southwest Papua New Guinea*. Doctoral Thesis. The University of Queensland

Holden, S. T., Deininger, K., & Ghebru, H. (2009). Impacts of low-cost land certification on investment and productivity. *American Journal of Agricultural Economics*, *91*(2), 359-373.

ICRAF. (2007). *Agroforestry for food security and healthy Ecosystems; Annual Report 2007-2008*. ICRAF.

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

ILCA. (1994). *ILCA Annual Program Report 1993/1994*. Addis Ababa. (International Livestock Center for Africa

Jamnadass, R., Place, F., Torquebiau, E., Malézieux, E., Iiyama, M., Sileshi, G. W. & Dawson, I. K. (2013). Agroforestry for food and nutritional security. *ICRAF Working Paper No. 170*. Nairobi: World Agroforestry Centre. DOI:

Jera, R., & Ajayi, O. C. (2008). Logistic modelling of smallholder livestock farmers' adoption of tree-based fodder technology in Zimbabwe. *Agrekon*, *47*(3), 379-392.

Jerneck, A., & Olsson, L. (2014). Food first! Theorising assets and actors in agroforestry: risk evaders, opportunity seekers and 'the food imperative'in sub-Saharan Africa. *International journal of agricultural sustainability*, *12*(1), 1-22.

Keil, A., Zeller, M., & Franzel, S. (2005). Improved tree fallows in smallholder maize production in Zambia: do initial testers adopt the technology? *Agroforestry systems*, *64*(3), 225-236.

Kiptot, E. & Franzel, S. (2012). Gender and Agroforestry in Africa: A review of women's participation. *Agroforestry Systems*, *84*(1), 35–58.

Kumar, B. M., & Nair, P. R. (2004). The enigma of tropical homegardens. *Agroforestry Systems*, *61*(1–3), 135–152.

Kwale County Government. (2013). *Website of Kwale County Government*. Kwale County Government. http://www.kwalecountygov.com/

Lasco, R. D., Espaldon, M. L. O., & Habito, C. M. D. (2016). Smallholder farmers' perceptions of climate change and the roles of trees and agroforestry in climate risk adaptation: evidence from Bohol, Philippines. *Agroforestry Systems*, *90*(3), 521–540.

Lewis, E. E. (2002). 10 Behavioural Ecology. *Entomopathogenic Nematology*, 205.

Céline Leroy, Alain Jauneau, Yves Martinez, Armelle Cabin-Flaman, David Gibouin, Jérôme Orivel, Nathalie Séjalon-Delmas, Exploring fungus–plant N transfer in a tripartite ant–plant–fungus mutualism, *Annals of Botany*, Volume 120, Issue 3, September 2017, Pages 417–426, https://doi.org/10.1093/aob/mcx064

Lindell, I. (2010). The Changing Politics of Informality-Collective Organizing, Alliances and Scales of Engagement. In I. Lindell (ed.), *Africa's Informal Workers: Collective Agency, Alliances and Trans-National Organizing in Urban Africa* (pp. 1-30). London: Zed Books.

Lulandala, L. L. L**.** (2009). *Tropical production systems: Agroforestry concepts, systems, practices, potentials, constraints, Research and Training needs*. MSc. Forestry Lecture Notes, Sokoine University of Agriculture.

Makumba, W., Akinnifesi, F. K., Janssen, B., & Oenema, O. (2007). Long-term impact of a gliricidia-maize intercropping system on carbon sequestration in southern Malawi. *Agriculture, Ecosystems & Environment*, *118*(1–4), 237–243.

Maliki, R., Cornet, D., Floquet, A., & Sinsin, B. (2012). Agronomic and economic performance of yam-based systems with shrubby and herbaceous legumes adapted by smallholders. *Outlook on Agriculture*, *41*(3), 171-178.

Michon, G., & De Foresta, H. (1995). The Indonesian agro-forest model. Conserving biodiversity outside protected areas. In Halladay, P. & Gilmour, D. A. (eds.), *The role of traditional agro-ecosystems*. IUCN, Gland, Switzerland, and Cambridge, UK.

Mugure, A., Oino, P. G., & Sorre, B. M. (2013). Land ownership and its impact on adoption of

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

agroforestry practices among rural households in Kenya: a case of Busia county. *International Journal of Innovation and Applied Studies*, *4*(3), 552–559.

Nyambari, P. M. (2008). Farmers in socio-economic diversification in Nyeri Division? *Les Cahiers d'Outre Mer*, (3), 303–322.

Nzilano, B. L. (2013). *Contribution of agroforestry home gardens to household food security and income generation among communities in Mbeya rural district, Tanzania*. Doctiral Thesis. Sokoine University of Agriculture.

Oduol, P. A., Nyadzi, G., Swai, R., Schueller, M., Gama, B., Matata, S., … Mbaruk, D. (2006). Adoption and impact of agroforestry technologies on rural livelihoods in southern Africa. In *second national agroforestry and environment workshop, Mbeya, Tanzania* (Vol. 14). Retrieved from http://www.worldagroforestry.org/downloads/Publications/PDFS/PP06281.doc

Oginosako, Z., Mathenge, S., Simons, T., & Simutu, P. (2003). *Composition and structure of indigenous and exotic tree species in the agro-ecological zones of the southern foot of Mount Kenya*.

Oino, P. & Mugure, A. (2013). Farmer-oriented factors that influence adoption of agroforestry practices in Kenya: Expériences from Nambale District, Busia County. *International Journal of Science and Research*, *2*(4), 450–456.

Place, F. (2009). Land tenure and agricultural productivity in Africa: a comparative analysis of the economics literature and recent policy strategies and reforms. *World Development*, *37*(8), 1326–1336.

Quisumbing, A. R., Otsuka, K., Suyanto, S., Aidoo, J. B., Payongayong, E., Report, R., & Washington, D. C. (2001). *Land, Trees, and Women Evolution of Land Tenure Institutions in Western Ghana and Sumatra*. Retrieved from http://www.worldagroforestry.org/downloads/Publications/PDFS/RP01215.pdf

Regmi, B. N. (2003). Contribution of agroforestry for rural livelihoods: A case of Dhading District, Nepal. In *International Conference on Rural Livelihoods, Forests and Biodiversity* (pp. 19–23).

Segnon, A.C.; Achigan-Dako, E.G.; Gaoue, O.G.; Ahanchédé, A. Farmer's Knowledge and Perception of Diversified Farming Systems in Sub-Humid and Semi-Arid Areas in Benin. Sustainability **2015**, 7, 6573–6592.

Silvestri, S., Sabine, D., Patti, K., Wiebke, F., Maren, R., Ianetta, M., … & Nicolas, N. (2015). Households and food security: Lessons from food secure households in East Africa. *Agriculture & Food Security*, *4*(1), 23.

Susila, A. D., Purwoko, B. S., Roshetko, J. M., Dahlia, L., Kartika, J. G., Wijaya, K., ... & Sombat panit, S. (2012). *Vegetable agroforestry systems in Indonesia*. Beijing, China: World Association of Soil and Water Conservation (WASWAC), Nairobi, Kenya: the World Agroforestry Center (WAC-ICRAF).

Thangata, P. H., Hildebrand, P. E., & Gladwin, C. H. (2002). Modelling agroforestry adoption and household decision making in Malawi. *African Studies Quarterly*, *6*(1), 271–293.

Thirtle, C., Irz, X., Lin, L., McKenzie-Hill, V., & Wiggins, S. (2001). Relationship between changes in agricultural productivity and the incidence of poverty in developing countries. *Report Commissioned by the Department for International Development, London*.

Tukan, C. J. M., Yulianti, J. M., & Darusman, D. (2002). *Pemasaran kayu dari lahan petani di propinsi Lampung*. Bogor, Indonesia.

Article DOI: https://doi.org/10.37284/eajfa.5.1.681

Waha, K., Zipf, B., Kurukulasuriya, P., & Hassan, R. M. (2016). An agricultural survey for more than 9,500 African households. *Scientific Data*, *3*, 160020. https://doi.org/10.1038/sdata.2016.20

Wiebe, K. & Maxwell, D. (1998). Land Tenure and Food Security: A Review of Concepts, Evidence and Methods. *Research Paper No 129*. University of Wisconsin, Madison.

Zomer, R. J., Trabucco, A., Coe, R., Place, F., van Noordwijk, M., & Xu. J. C. (2014). Trees on farms: an update and reanalysis of agroforestry's global extent and socio-ecological characteristics. *Working Paper 179*. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. DOI: 10.5716/ WP14064.PDF

