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Some socio-economic drivers of agroforestry adoption in Temiyotta Location, Nakuru County, Kenya

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ABSTRACT

This paper provides empirical evidence of some socio-economic drivers of adoption of agroforestry practices among small scale farmers in Temiyotta Location, Nakuru County, Kenya. A stratified random sampling procedure was used to select 86 household heads from the three Sub-locations making up the study area, namely Ikumbi, Murginye, and Cheptagum. Primary data were collected from the field using questionnaires, photography, and observation. Secondary data were obtained from published and unpublished sources. Data analysis was carried out using both descriptive and inferential data tools. Research results indicate farm size, household annual income, and household size as the key drivers of agroforestry adoption in the study area. There was no significant statistical relationship between the education level of the household head and adoption of agroforestry practices. It is concluded that socio-economic factors do influence agroforestry adoption in the study area and must, therefore, be incorporated into any interventions meant to enhance agroforestry adoption and diffusion.

1. Introduction

The significance of agroforestry as a sustainable land management practice is well documented (Quandt et al. 2018, Coulibaly et al. 2017, Mkonda and He 2017, Mbow et al. 2014) Accordingly, it improves the value of food crops (for example through adoption of fertilizer trees) and hence contributes to food security, enhances farm households' incomes through provision of products for sale and contributes to climate change adaptation and mitigation. Agroforestry has also been shown to contribute to households' resilience through the provision and support of alternative livelihood activities as well as building resilience to droughts and floods (Quandt et al. 2017).

Despite the benefits of agroforestry, its widespread adoption in Sub-Saharan Africa (SSA) remains low (Meijer 2015, Mbow et al. 2014). In some cases, agroforestry practices have been abandoned after initial adoption. For instance, some farmers in Wagai, Ukwala and Ugunja Divisons of Siaya District (now Siaya County), Kenya, abandoned agroforestry at the end of the technical assistance and support from the CARE Agroforestry Extension Project (AEP) (Hambly 1999). It has also been noted that adoption and diffusion of agroforestry practices have lagged behind scientific and technological advances in agroforestry research, hence reducing the potential benefits and impacts of agroforestry (Nkameru and Manyong 2005, Mercer 2004, Adesina et al.2000). Jerneck and Olsson (2013) have noted that the agroforestry adoption gap in SSA remains largely unexplained.

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One of the objectives of the research reported here was to determine some of the socio-economic drivers of agroforestry adoption. This was aimed at contributing to the development of an explanatory framework for understanding agroforestry adoption in a Kenyan context, hence contributing to sustainable land management and livelihoods. The main types of agroforestry practices promoted in the study area were: dispersed trees in cropland (with Grevillea robusta and Calliandra calothyrsus as the main tree species); Tree on boundaries (with Grevillea robusta as the main tree species); and woodlots (with Grevillea robusta as the main tree species). Plate 1a and b show agroforestry practices in the study area.

2. Materials and Methods

2.1 Study Area

The study was carried out at Temiyotta Location which lies in Nakuru County, Kenya. Nakuru County is located in the south eastern part of the Rift Valley and is bordered by 7 counties with Baringo to the north, Laikipia to the north east, Nyandarua to the east, Kajiado to the south, Narok to the south west with Bomet and Kericho to the west. The County covers an area of 7,235.3 km2 and lies between longitudes 35o 28' and 35o 36' and latitudes 0o 12' and 1o 10' South. Temiyotta Location lies within longitudes; 35o 34' E to 35o 41' E, and latitudes 0o 18' S to 0o 25'S. It covers a total area of 5900.88 hectares (County Government of Nakuru 2018).

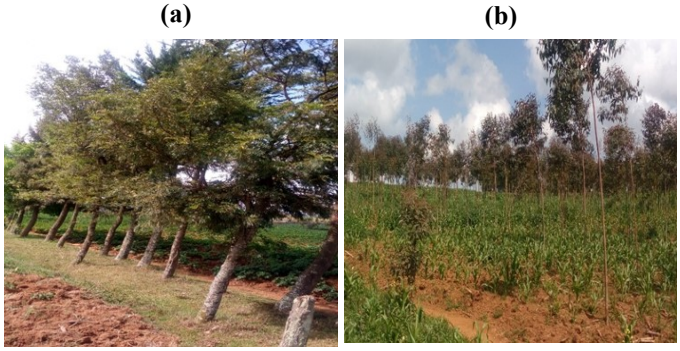

Plate 1: Grevillea robusta as a boundary mark (a) and a young woodlot of Eucalyptus saligna (b)

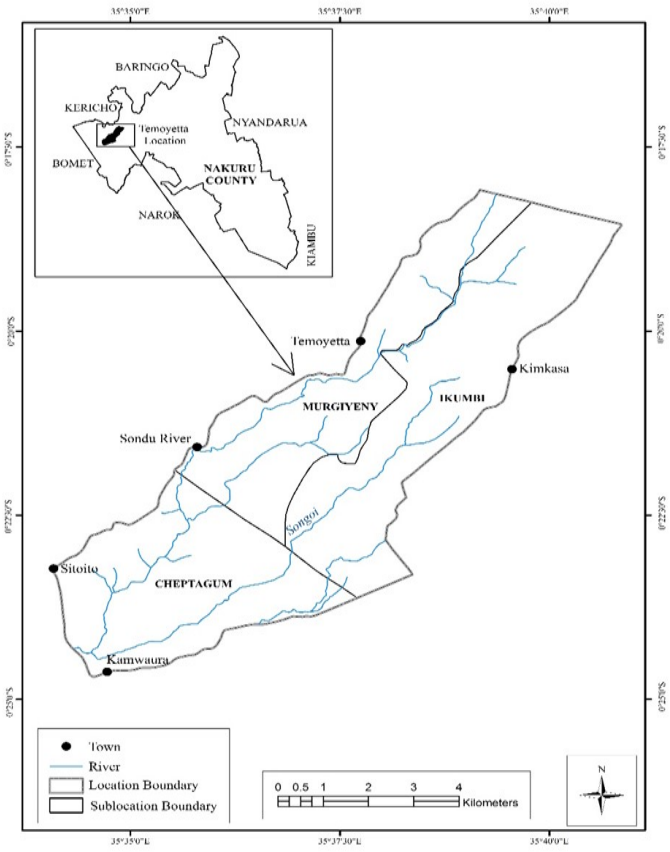

Figure 1: Location of Temiyotta in Nakuru County
Source: Survey of Kenya (2011)

2.2 Data Collection and Analysis

The target population in this study was small scale farmers in Temiyotta Location. A multi-stage stratified random sampling procedure was used to select 86 household heads from three villages that were randomly from the three Sub-Locations making up the study area. The villages selected were Sitoito Tebere and Arimi with a total of 595 households. The sample size was determined using the formula provided by Nassiuma (2000) as follows:

$$n = (NCv^2) / (Cv^2 + (N - 1) e^2$$

Where; n = the desired sample size,
N = Target population (595)
Cv = Coefficient of variation (0.5)
e = Tolerance at desired level of confidence (0.05) at 95% confidence level.

$$n = (595x0.5^2)/(0.5^2) + (595-1) 0.05^2$$

$$n = 86$$

The samples were proportionately selected from each of the villages as shown in Table 1.

Table 1: Sample Size and Sampling of the Households

Sub-Location	Selected villages	Household size	Selected household size
Ikumbi	Sitoito	243	35
Cheptagum	Tebere	198	29
Murginye	Arimi	154	22
Total		595	86

Source: Fieldwork 2017

Primary data were collected from the field using questionnaires, photography, and observation. Secondary data were obtained from published and unpublished sources. These included published research reports, policy documents, books as well as unpublished research theses and reports. Data analysis was carried out using both descriptive and inferential data tools. The key descriptive data tools were frequencies and percentages while the chi-square test of independence was the key inferential data tool.

3. Results and Discussion

3.1 Farm size and adoption of agroforestry

To establish the relationship between farm size and adoption of agroforestry, the study respondents were asked to state their farm sizes and whether they planted trees in their farm together with other crops. Table 2 shows the research results.

Table 2: Relationship between farm size and adoption of agroforestry

Farm size (acres)	Planted trees with crops in the farm					
	Yes		No		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percent-age
0.5-2	10	15.38	14	66.67	24	27.91
2.01-4	27	41.54	3	14.29	30	34.88
4.01-7	19	29.23	3	14.29	22	25.58
7.01-10	9	13.85	1	4.76	10	11.63
Total	**65**	**100**	**21**	**100**	**86**	**100**

Source: Fieldwork 2017

Research findings indicate that households with farm sizes 3-4 acres and 5-7 acres account for a combined 70.77% of agroforestry adopters in the study area. Households with the smallest farm size (0.5-2 acres) accounted for 66.67% of the non-adopters while those with the largest farm size (8-10 acres) accounted for the least percentage (4.76%) of the non-adopters. To determine the statistical significance of these findings, a chi-square test of independence was performed. The null hypothesis tested is that there is no significant relationship between farm size and agroforestry adoption. Table 3 shows the observed and expected values for farm size and agroforestry adoption.

Table 3: Observed and expected values for farm size and adoption of agroforestry

Farm size (acres)	Planted trees with crops in the farm			
	Yes		No	
	Observed	Expected	Observed	Expected
0.5-2	10	18.14	14	5.86
Above 2	55	46.86	7	15.14

Source: Fieldwork 2017

With a chi-square value of 20.75 and p=5.23E-06 (which is less than the statistical significance level of 0.05), the null hypothesis is rejected. This implies that there is a statistically significant relationship between farm size and adoption of agroforestry. Accordingly, households with larger farm sizes are more likely to adopt agroforestry as compared to those with smaller farm sizes up to a certain limit. Large farm sizes provide more space for agroforestry practices as well as enabling farmers diversify the practices. For instance, the adoption of agrosilvopastoral systems requires relatively large land. This research finding is collaborated by Ajayi and Kwesiga (2003) Orisake and Agomuo (2011) and Mulatu et al. (2014). In a synthesis of studies on adoption of improved fallows in Zambia, Ajayi et al. (2003) noted that in some studies, a positive relationship between farm sizes and farmer decisions to establish and adopt improved fallows had been established. In a study on the determinants of adoption of agroforestry technology in Eastern Cape Province in South Africa, Mulatu et al. (2014) indicated that the land size owned was one of the key determinants. Orisakwe and Agomuo (2011) in a study on the adoption of improved agroforestry technologies, among farmers in Imo State, Nigeria, also established the significance of land size as an explanatory variable for the adoption of agroforestry technologies. Kassie (2016) has noted that an increase in farm size increases the probability of adoption of agroforestry. Furthermore, Mwase et al. (2015) indicate that land availability influences the type of agroforestry technology that farmer can put into practice hence affecting its adoption.

3.2 Household annual income and adoption of agroforestry

To determine the relationship between household income and adoption of agroforestry in the study area, the study respondents' total household income was linked to their integration or non-integration of agroforestry practices. According (Table 4), the income category Kenya Shillings 20001-50000 accounts for the highest percentage of adopters followed by the income category Kenya shillings 50001-100000. The two categories combined account for 81.54% of all adopters as compared to a combined 66.67% of non-adopters in the same categories. Apparently households with a total annual income of Kenya shillings 20000 and below are likely to be non-adopters while households with a total annual income of Kenya shillings 100001 and above are likely to be either adopters or non-adopters.

To further unearth the relationship between income and adoption of agroforestry, the data were subjected to a chi-square test for independence. The null hypothesis tested was that household income is not significantly related to the adoption of agroforestry in Temiyotta Location. Table 5 shows the expected and observed values for household annual income and adoption of agroforestry.

Table 5: Observed and expected values for household annual income and adoption of agroforestry

Annual income (Kenya Shillings)	Planted trees with crops in the farm			
	Yes		No	
	Observed	Expected	Observed	Expected
Below 20001	9	11.34	15	3.66
20001-50000	32	30.99	9	10.01
Above 50000	24	22.67	6	7.33

Source: Fieldwork 2017

With a chi-square value of 36.07 and p=1.47E-08 (which is less than the statistical significance level of 0.05), the null hypothesis is rejected. This implies that there is a significant relationship between household income and adoption of agroforestry in the study area. Respondents earning relatively higher incomes are likely to adopt agroforestry as compared to those earning lower incomes (however, respondents earning above Ksh. 100,000 were not sufficiently represented in study sample and hence this finding may not apply to them).

Table 4: Total household income and adoption of agroforestry

Annual income (Kenya Shillings)	Planted trees with crops in the farm					
	Yes		No		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Below 5001	2	3.08	0	0	2	2.33
5001-10000	3	4.62	3	14.29	6	6.98
10001-20000	4	6.15	3	14.29	7	8.14
20001-50000	32	49.23	9	42.86	41	47.67
50001-100000	21	32.31	5	23.81	26	30.23
100001-250000	2	3.08	1	4.76	3	3.49
Above 250000	1	1.54	0	0	1	1.16
Total	65	100	21	100	86	100

Source: Fieldwork 2017

It is likely that higher household income implies higher disposable income that may be channeled to engagement in agro-forestry and vice versa. Furthermore, higher income earners are likely to afford the various agroforestry technologies and implement them their farms as a basis for further diversification of their livelihood sources. This finding concurs with Mulatu et al. (2014), Mercer and Pattanayak (2003) and Keil et al. (2005).

3.3 Household size and adoption of agroforestry

It was of interest to establish whether household size had any influence on adoption of agroforestry in the study area. Table 6 shows the research results.

Table 6: Household size and adoption of agroforestry

House-hold size	Planted trees with crops in the farm					
	Yes		No		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1-2	4	6.15	2	9.52	6	6.98
3-4	13	20	3	14.29	16	18.60
5-6	23	35.39	2	9.52	25	29.07
7-8	21	32.31	6	28.57	27	31.40
9-10	4	6.15	3	14.29	7	8.14
Above 10	0	0	5	23.81	5	5.81
Total	**65**	**100**	**21**	**100**	**86**	**100**

Source: Fieldwork 2017

The highest concentration of agroforestry adopters (35.39%) is in the household size 5-6 members followed by the household size 7-8 members. As far as non-adoption is concerned, the household size 7-8 members accounts for the highest percentage of 28.57% followed by households with above 10 members. The combined percentage of adopters in household sizes 5-6 members and 7-8 members is 65.70% as compared with 38.09% for non-adopters in the same household sizes. Apparently, households with more than 10 members are not likely to adopt agroforestry. To determine whether there is a significant relationship between household size and adoption of agroforestry, the data were subjected to a chi-square test of independence. The null hypothesis tested was that household size does not significantly influence the adoption of agroforestry. Table 7 shows the observed and expected values for household size and adoption of agroforestry.

With a chi-square value of 15.37 and p=1.53E-03 (which is less than the statistical significance level of 0.05), the null hypothesis is rejected. This implies that there is a significant relationship between household size and adoption of agroforestry in the study area. Accordingly, relatively larger household sizes (5-8 members) are likely to adopt agroforestry. This research finding concurs with the findings of Nkamleu and Manyong (2005), Ezeh and Nwachuku (2010), Obeng and Weber (2014), and Sanou et al. (2019). Larger family sizes translated to more labour essential for the implementation of agroforestry practices and technologies.

Table 7: Observed and expected values for household size and adoption of agroforestry

House-hold size	Planted trees with crops in the farm			
	Yes		No	
	Observed	Expected	Observed	Expected
1-4	17	16.63	5	5.37
5-6	23	18.90	2	6.11
7-8	21	20.41	8	6.59
9+	4	9.07	21	2.93

Source: Fieldwork 2017

3.4 Education level of the household head and adoption of agroforestry

To establish whether the education level of the household head had any influence on the adoption of agroforestry, the study respondents' (household head) education was linked to the practice of agroforestry. The research results are shown in Table 8. Accordingly, among the households who had adopted agroforestry, it was apparent that the higher the level of education (above 10 years) of a household head, the higher the adoption of agroforestry. On the other hand, household heads who had up to 10 years of education accounted for only 35.29% of the adopters.

Table 8: Education level of household head and adoption of agroforestry

Years in school	Planted trees with crops in the farm					
	Yes		No		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1-10	24	35.29	9	50	33	38.37
Above 10	44	65.71	9	50	53	61.63
Total	**68**	**100**	**18**	**100**	**86**	**100**

*Source***:** Fieldwork 2017

To establish the significance of the research findings, a chi-square test of independence was performed. The null hypothesis tested was that the education level of the household head does not influence the adoption of agroforestry. Table 9 shows the observed and expected values for education of the household head and the adoption of agroforestry.

Table 9: Observed and expected values for education level of household head and adoption of agroforestry

Years in school	Planted trees with crops in the farm			
	Yes		No	
	Observed	Expected	Observed	Expected
1-10	24	26.09	9	6.91
Above 10	44	41.91	9	11.09

Source: Fieldwork 2017

With a chi-square value of 1.298 and p=0.255 (which is more than the statistical significance level of 0.05), there is not enough evidence to reject the null hypothesis. This implies that the observed relationship between education of the household head and adoption of agroforestry in the study area is not statistically significant. This finding disagrees with findings of other researchers. In a review of publications on adoption of agroforestry in Southern Africa, Mwase et al. (2015) noted that 44.8% of the publications indicated high illiteracy levels among farmers as one of the key barriers to adoption of agroforestry. This is because it affected their ability to comprehend agroforestry practices. Maluki et al. (2016) in a study on adoption levels of agroforestry tree types and practices by smallholders in Makueni County noted that adoption of agroforestry was significantly influenced by among other factors, the education level of the household head. However, Mercer and Pattanayak (2003) in an empirical analysis on agroforestry adoption in Leyte, Philippines established that education of the household head was not significantly related to adoption of agroforestry. As far as the study area is concerned, it is likely that more educated respondents had other livelihood options (for example as teachers and business people) lessening their dependence on agroforestry.

Conclusion

On the basis on the research findings, it may be concluded that socio-economic factors do influence agroforestry adoption in the study area. These factors are farm size, household size and household annual income. These factors are positively correlated with adoption of agroforestry in the study area. However, there was insufficient evidence to support a relationship between household head level of education and the adoption of agroforestry. The identified key factors should be incorporated into any interventions meant to enhance agroforestry adoption and diffusion in the study area. There is need for further research on the influence of household head level of education on the adoption of agroforestry.

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