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Eco-Friendly Farming Practices and the intensity of their adoption in the agroecosystems of Embu County, Kenya

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Abstract

This study was conducted among households of Embu County in Kenya to determine the socioeconomic factors that influenced adoption of Eco-Friendly Farming Practices (EFFPs). Earlier studies had indicated clearly that Embu County was experiencing soil erosion, pollution and soil acidification, yet EFFPs had been introduced to counter these environmental challenges. Therefore the study sought to find out the influence of socioeconomic factors on adoption of the EFFPs. Ex post facto research design was used. Through multistage random sampling 402 household heads were selected and all the 32 extension officers in the area were interviewed. 71.1% of the households were considered high adopters while 2% had not adopted low intensity was found with EFFPs such as limited use of inorganic pesticides and soil testing; medium intensity was seen on adoption of green manuring, composting, integrated pest management, minimum tillage and mulching. EFFPs with high adoption intensity included: Increasing soil and water conservation measures, cover cropping, use of less herbicides, intensified inter cropping, cultivating leguminous crops, agro-forestry, crop rotation and cultural methods in weeding were some of the EFFPs with high intensity adoption. The study found no statistically significant relationship between the intensity of adoption and the uptake of EFFPs among farming households of Embu County, Kenya. Therefore understanding the type and intensity of EFFPS adopted would be critical in designing effective environmental programs in the County.

Keywords: *Adoption, Eco-Friendly Farming Practices (EFFPs), Intensity, Households*

1. Introduction

The environment and its resources form the basis for livelihood of human beings, sustenance of economies and agricultural development in the world (Mutuku *et al.*, 2017). Use of environmental resources for agriculture is central in the global economy accounting for over 24% of the global Gross Domestic Product (Smith, *et al.*, 2007). The green revolution involved intensified mechanization, intensified use of pesticides and excess

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inorganic fertilizers, expansion of irrigated land, specialization and breeding of high yielding crops. While the green revolution led to a sudden increase in production especially in South America and Asia in 1960s, the increase in production was not sustainable. In addition, this intensification of conventional agriculture has stretched environmental resources to limits thus weakening their natural processes (United Nations Environment Programme [UNEP], 2008). For instance these conventional agricultural practices have been associated with acute soil degradation (Ngetich *et al.*, 2012), environmental pollution, soil acidification, unsustainable production, biodiversity loss and salinization (Hurni, 2000; Rasul and Thapa, 2004; Roling, 2005).

In addressing the environmental challenges associated with agriculture and simultaneously provide agroecosystem services, environmentalists have supported a paradigm shift by encouraging adoption of Eco-Friendly Farming Practices (EFFPs). Success stories of EFFPs have been recorded in South Africa, Zimbabwe and Zambia (Yadate, 2007). Despite the environmental benefits associated with EFFPs, their adoption rates in many African countries remain low (Giller, *et al.*, 2009; International Assessment of Agricultural Knowledge, Science and Technology for Development [IAASTD], 2009). In Kenya, very low (0-6%) adoption rates of EFFPs have been reported (Republic of Kenya, 2007). However, despite the low adoption, some households had been reported to have high adoption intensity of EFFPs (Olwande *et al.*, 2009; and Suri, 2011). The study therefore sought to examine the influence of socioeconomic factors on adoption of EFFPs in Embu County. This is because appropriate and effective intervention measures would be better developed after examining the intensity of adoption of EFFPs through which environmental conservation would be realized.

2. Materials and methods

The study was carried out in Embu County in Eastern part of Kenya. The choice of a study location was determined by existence of a knowledge gap (Singleton, 1993). In this case, intensive and often inappropriate use of environmental resources for agricultural production had led to environmental challenges in Embu County. Embu County borders Kirinyaga County to the West, Kitui County to the east, Tharaka Nithi County to the North and Machakos County to the South. The County is located between 37^{0}3' and 37^{0}9' east. Embu County rises from about 515 m above sea level at the Tana basin in the east to over 4870 m on top of Mt. Kenya in the North West. The Nyandarua and Mt. Kenya ranges have influenced the soil types and the agroecology of the study area. The highlands have humic nitosols that are well drained and very deep.

The study was conducted using ex post facto research design to determine the influence of socioeconomic factors on adoption of EFFPs. The study targeted all the 32 agricultural extension officers in the Embu West, Embu East and Embu North sub-counties. These extension officers represented the informed specialists, and the 80,138 farming household heads being the users of the EFFPs. The sample used in the study was selected through a multistage sampling technique. The first stage involved purposive selection of the block of the three sub-counties. There are 80,138 households in Embu County involved directly or indirectly in farming activities. A sample size of 402 household heads was selected for the study.

3. Results and discussion

3.1. Intensity of adoption of eco-friendly practices

The respondents were to indicate against each specific EFFP, the status of adoption (never, adopted once and abandoned; or more than once). Those who had never adopted were classified as non-adopters; those who had adopted once were classified as low adopters while high adopters were those who had adopted and continued using one or more of the EFFPs. The results obtained on the status of adoption of EFFPs by households are presented in Table 1.

Table 1: Status of adoption of Eco-Friendly Farming Practices by households

Status of Adoption	Frequency	Percent
Non Adopters	7	1.8
Low Adopters	109	27.1
High Adopters	286	71.1
Total	**402**	**100.0**

Majority (71.1%) of the sampled households were considered high adopters. These households had adopted two or more EFFPs and continued using them upon realizing the environmental benefits accruing from EFFPs. Slightly more than a quarter (27.1%) of the sampled households was a group of low adopters having adopted an EFFP just once. A paltry 2% of the respondents had not deliberately adopted any of the EFFPs (Table 1).

The results represent a relatively high number of adopters of EFFPs within Embu County contrary to earlier studies (Republic of Kenya, 2007; AGRA, 2010) which had reported low adoption rates of sustainable technologies in Embu County. These studies examined a particular practice unlike this study which evaluated a set of 16 EFFPs. From the wide range of EFFPs, a household was assessed on adoption of one or more practices from which a household decided to either adopt or not. In addition, long before the intensified and deliberate effort by the government and the non-governmental organizations in promoting EFFPs in Embu County, some households had already adopted some farming practices that would be considered eco-friendly. More effort would have to be made to ensure that the more than a quarter (27.1%) low adopters intensified their adoption by addressing the constraints to adoption.

Although over 70% of the respondents were high adopters, the number of EFFPs adopted per household varied. The number of EFFPs observed per sampled household was recorded. Based on the percentage of the households adopting an EFFP, the intensity of adoption was grouped into three classes: high intensity adoption (for 75-100%), medium adoption (50-74%) and low intensity adoption (49% and below). The results for the intensity adoption of EFFPs are presented in Table 2.

Table 2: Intensity of adoption of Eco-Friendly Farming Practices

S. No.	EFFP	Adoption status (%)			Degree of intensity
		Never	Only once	More than once	
1.	Limited use of inorganic pesticides	10.2	51.0	38.8	Low
2.	Soil testing	44.5	13.7	41.8	Low
3.	Reducing use of inorganic fertilizers	15.9	31.1	53.0	Medium
4.	Green manuring	23.9	14.7	61.4	Medium
5.	Increasing composting	26.6	5.7	67.7	Medium
6.	Use of integrated pest management	20.4	10.9	68.7	Medium
7.	Practicing minimum tillage	23.2	8.0	68.8	Medium
8.	Retaining plant residues on farm and mulching	3.2	25.2	71.6	Medium
9.	Increasing soil and water conservation structures	7.8	14.3	77.9	High
10.	Cover cropping	9.7	5.7	84.6	High
11.	Use of less herbicides	8.0	13.4	78.6	High
12.	Intensified inter cropping	12.2	0.2	87.6	High
13.	Cultivating leguminous crops	2.2	10.2	87.6	High
14.	Introduced agro-forestry species on farms	1.9	8.0	90.1	High
15.	Increasing crop rotation	2.2	2.0	95.8	High
16.	Used cultural methods in weeding	2.2	0	97.8	High

According to the results on Table 2, limited use of inorganic pesticides was adopted by about 38% of the respondents and 41.8% of the respondents had carried out soil testing at least once. Therefore out of the 16 EFFPs evaluated, soil testing and low use of inorganic fertilizers were practices found to have low adoption intensity since they were adopted in less than 50% of the households. Within medium level of intensity of adoption (50-74%), were six EFFPs including, reduced use of inorganic fertilizers (53%), green manuring

(61.4%), increased composting (67.7%) and retaining plant residues on farms for mulching (71.6%). These four EFFPs are geared towards soil fertility managements. Use of integrated pest management approaches (68.7%) and practicing minimum tillage (68.8%), were also EFFPs recorded with medium intensity of adoption. Almost all the extension officers had observed these EFFPs on household farms.

High intensity of adoption (more than 75%) was observed for eight EFFPs. This implied that at least seven out of 10 adopting households, one or more of these eight EFFPs would be found. These highly adopted EFFPs were: increasing soil and water conservation measures (77.9%), use of less herbicides (78.6%), cover cropping (84.6%), intensified intercropping (87.6%), cultivating leguminous crops (87.6%), practicing agroforestry on farms (90.1%), crop rotation (95.8%) and using cultural methods of weed control (97.8%). These EFFPs were also widely observed by majority of extension officers (Table 3).

Table 3: Common Eco-Friendly Farming Practices as observed by extension officers

S.No.	EFFP	Yes (%)	No (%)
1.	Limited use of inorganic pesticides	50	50
2.	Soil testing	26.3	73.7
3.	Reducing use of inorganic fertilizers	22.4	77.6
4.	Green manuring	61.4	38.6
5.	Increasing composting	62.4	37.6
6.	Use of integrated pest management	84.0	16
7.	Practicing minimum tillage	77.6	22.4
8.	Retaining plant residues on farm and mulching	100	0
9.	Increasing soil and water conservation structures	100	0
10.	Cover cropping	100	0
11.	Use of less herbicides	88.8	11.2
12.	Intensified inter cropping	100	0
13.	Cultivating leguminous crops	100	0
14.	Introduced agro-forestry species on farms	100	0
15.	Increasing crop rotation	93.8	6.2
16.	Used cultural methods in weeding	100	0

Although most of the EFFPs are complementary and it would be wise to have them adopted as a package, some households adopted some and left out some. This is consistent with earlier studies that have repeatedly proven that households do not adopt full package of a technology even with intensive extension services. Smale *et al.* (1995) observe that households will tend to adopt some or part(s) of a component of a given technological package. So in as much a wide range of EFFPs were introduced in Embu County, some households have chosen to adopt part of the components. From a package of soil fertility practices, they may choose composting and leave out green manuring; from soil and water conservation techniques, they may choose to do terraces and leave out cover cropping. This partial adoption of technologies, can be improved with thorough extension services and training. Full benefits of EFFPs would be realized if a household adopted a full set of tillage practices, soil fertility practices, integrated pest and disease management and soil and water conservation. When adopted in full these components support and complement each other. A wide range of livestock (which adds to biodiversity at farm level) gives a variety of manure that would be used in composting. Napier grass and hedgerows (fodder for livestock) planted on terraces (soil water conservation) serve more use than the primary role. Inter cropping of maize with napier grass and *desmodium spp* have been known to reduce incidences of maize stalk borer through the push and pull principle. This implies that using this technique of pest management in maize would also require a household to have livestock to feed on the *desmodium spp*.

3.2. Eco-Friendly Farming Practices adopted by households

Since extension officers should visit farmers regularly for advice and training, the study sought to find out whether the extension officer had noted the EFFPs adopted by households in Embu County. The EFFPs observed by the extension officers are presented in Table 3.

All the interviewed extension officers reported having observed the following EFFPs in Embu County: mulching, cultivation of leguminous plants, intensive soil and water conservation measures, cover cropping, intensified intercropping, crop rotation, cultural weed management and agroforestry. A great majority (more than 80%) of the extension officers had noted EFFPs such on, integrated pest management, crop rotation and increased crop rotation on the farms they visited (Table 3). Half of the extension officers noted that households continued use of inorganic pesticides. This corroborates the low adoption intensity reported by households on the limited use of inorganic pesticides. In fact, slightly more than half (51%) of the household respondents used limited inorganic pesticides just once and abandoned. This may have been as a result emergence of new pests or disease vectors that required more application of the inorganic pesticides. Ineffectiveness of some ecological approaches in managing pests and diseases could have also contributed to more households continuing with use of more pesticides. However, lack of knowledge on pests and disease management as well as the ineffectiveness of organic pesticides and ecological approaches (Njeru, 2015) could have contributed to abandoning of these EFFPs.

As noted in Table 3, nearly half (44.5%) of the respondents had never carried out soil testing. This was finding was also supported by three quarters (73.7%) of the extension officers (Table 3). This implies the farmers had missed on crucial information regarding the health and fertility status of their soils. Soil is natural resource that needs proper management since it is a medium on which crops are anchored, obtain nutrients and grow. To sustain optimal crop performance and yield, the nutrients (exhaustible resource) from the soil must be replenished in quantities similar to what was used by the growing crops. Replenishment of these nutrients can happen naturally (through the nutrient cycles) or through additional of inorganic fertilizers and / or organic resources. Application of excess fertilizers (especially inorganic fertilizers) causes pollution. Similarly, adding wrong soil amendments and erroneous quantities would greatly reduce crop yield thus endangering food security. These inappropriate soil management practices would be rectified with regular soil testing. The lack of soil testing among farming households as a regular practice had also been noted in other studies (Njoroge, 2000; and Njeru, 2015). The high cost of soil testing, few laboratories and failure of many farmers on the importance of soil testing, could be the reasons for the low adoption of soil testing among the households in Embu County.

EFFPs if well adopted on farms, confer a wide range of ecological, social and economic benefits. However, these benefits vary based on the length of adoption; the number and type of EFFPs adopted. This may partially explain the variance in adoption of the EFFPs by households as revealed by the study.

3.2.1. Mulching

Information on Tables 2 and 3 indicate that soil and water conservation measures and soil fertility techniques were among the very common EFFPs adopted by households in Embu County. These two broad classes of practices in sustainable agroecosystems aim at "feeding" and protecting the soil as the resource base for production to ensure food security. Since soil cover is the main factor that influences soil erosion (Kinama *et al*., 2005), EFFPs such as cover cropping, mulching, retaining crop residues on farms and agroforestry become vital components in sustainable agroecosystems (Lampkin, 1994; and IFOAM and FiBL, 2006).

Mulching is widely adopted because of the benefits associated with it. Mulching, other than reducing splash erosion, reducing growth of weed, conserving soil moisture and improving the soil structure, the mulch (on decomposition) will add to the organic matter in the soil (Chomba, 2016). The organic matter added thereof improves soil structure and adds to the nutrients levels in the soils. Areas of Embu County (UM1 and UM2) receiving heavy rainfall, mulching has been found to reduce surface run off by half and soil erosion by more than four fifths (Kiepe *et al*., 1995). Mulching also manipulates the soil microclimate by reducing water loss through evaporation. This leads to reduced temperature in the soil (Cronje, 2001). This implies that moisture is conserved within the soil and this improves crop performance even during dry seasons. By extension this improved moisture retention in soils greatly reduces the amount of water that would have otherwise been used on crops (through irrigation), thus reducing strain on the already scarce water resources in Embu County. Therefore the combined and long-term benefits of mulching would not only assure food security to the practicing households, but also support environmental conservation. The greatest challenge to mulching is inadequate or unavailability of appropriate mulch. The use of organic materials for mulching would also reduce the use of the same organic resources for composting. Therefore the setting of these EFFPs needs proper layout and planning so that these components complement each other.

3.2.2. Agrobiodiversity and agroforestry

An agroecosystem is considered more stable based on the variety and choice of plants components cultivated. A variety of species and genes in an agroecosystem would render it high on the biodiversity rating. Various agroforestry tree species and crops were found among households. Results of the various agroforestry components adopted are shown in Table 4.

Table 4: Main crops and agroforestry tree species found in Embu County

	Crop/Tree/Shrubs	**Percent**
Cash crops	Tea (*Camellia sinensis*)	29.2
	Khat (*Catha edulis*)	36.1
	Macadamia (*Macadamia spp*)	67.3
	Coffee (*Coffea spp*)	71.2
Food crops	Millet (*Eleusine corocana*)	23
	Cassava (*Manihot esculenta)*	47
	Yams (*Dioscorea spp*)	63.8
	Beans (*Phaseolus vulgaris*)	97.3
	Potatoes (*Solanum tuberosum)*	84.2
	Maize (*Zea mays*)	98.3
	Bananas (*Musa spp*)	100
Other agroforestry species	Calliandra (*Calliandra calothyrsus*)	16.5
	Leucaenia *(Leucaena leucocephala*)	22.8
	Avocado (*Persea spp*)	66.7
	Croton (*Croton macrostachyus*)	43.9
	Mangoes (*Mangifera indica*)	78.3
	Silky oak (*Grevillea robusta*)	99.4
	Napier grass (*Pennisetum purpureum*)	89.6

The main cash crops in order of adoption across the study area were coffee (71.2%), *Macadamia spp* (67.3%), *Catha edulis* (36.1%) and *Camellia spp* (29.2%). *Camellia spp* is mainly grown in UM1 and part of UM2 zones. However, coffee and macadamia remained very popular cash crops in Embu County. *Manihot esculenta* and *Eleusine corocana* were found in 47% and 23% of the households respectively. *Manihot* can do well in virtually all parts of Embu County, but farmers' poor attitude towards it renders it unpopular. Every interviewed household head had bananas on their farms. Common food crops were maize (98.3%), beans (97.3%), potatoes

(84.2%) and yams (63.8%). The beans and maize were widely cultivated because they form the staple food of the people of Embu County.

Grevillea robusta was a very common agroforestry species found in almost all households (99.4%) because of its wide range of uses including bee forage, timber, fodder, shade, soil and water conservation. The leguminous *Calliandra spp* and *Leucaena spp* used as livestock fodder were planted in hedgerows in 16% and 22.8% of the households respectively. Avocado and mango (fruit trees) trees were found in 66.7% and 78.3% of households respectively. This finding on variety of agroforestry and cropping systems in management of soil and water conservation agrees to a study by Hansen *et al*. (2017) on soil conservation practices in Embu County.

These crops and agroforestry practices (Table 4) when well adopted help in reducing soil and water loss on farms. Soil erosion have been observed in Embu County and recognized by majority of farmers (Okoba and De Graaff, 2004). Soil loss of up to 200 t/ha/yr in the central highlands (where Embu is situated) has been reported. This trend is worrying and measures to prevent soil loss must be instituted. This significant soil loss has been associated with unsustainable farming practices and failure to adopt EFFPs (NEMA, 2010). Soil and water conservation can either be enhanced by biological means (trees, shrubs), agronomical (crops) systems or physical structures (terraces, *fanya juu/fanya chini*). The variety of crops and the agroforestry species widely adopted by households have the potential to conserve soil and water on farms. The potential of maize and other crops in reducing soil loss has been recognized. Kinama *et al*. (2005) found out that on a farm practicing rotation of maize and cowpeas with *Senna siamea* in four seasons, mulched hedgerow plots recorded a cumulative reduction in soil loss from 100 t/ha to two t/ha. In addition, a marked reduction in surface run off from 100 to 20 mm was noted on the same plots.

Other than maize, a great majority of households had planted napier grass mainly on terraces, and maintaining hedgerows of agroforestry species such as *Calliandra spp* and *Leucaena spp*. These, too have been observed to greatly reduce soil and water loss on sloping land as demonstrated by Kiepe *et al*. (1995) and Kinamac*et al*. (2005). Mutegi *et al*. (2008) and Angima *et al*. (2008) through field measurements reported as high as 60% reduction in soil erosion on farms with agroforestry hedges. Mungai *et al*. (2001), assert that when trees and crops are well combined in agroecosystems, crops use environmental resources for their growth. In addition, the tree shading especially from good agroforestry species like *Grevillea robusta* which is found in 99.4% of the households of Embu County has been found to reduce evaporation by 23%.

Reduced evaporation and surface run off would also be enhanced by the cover crops commonly grown in the area including beans and sweet potatoes. The crops extensive roots hold and trap sediments eroded from farm lands. The falling leaves of these crops and trees decompose adding to the fertility and improving the structure of the soils where they occur. These benefits were long recognized by scholars in their studies (KIOF, 1999; and Mungai, *et al*., 2001). When soil and water are conserved, higher crop yields are realized which not only ensures food security but higher income to the households.

Households in the course of adopting these agroforestry practices might be greatly motivated by the need to provide food for their family and improve on their income levels, but inadvertently contribute to environmental conservation. Environmentally, these agroforestry practices reduce loss of soil and the nutrients therein. In absence of these soil and water conservation measures, soil losses would be observed. The carrying away of top soil rich in nutrients (especially phosphates and nitrates) by water through surface run off causes eutrophication in the receiving aquatic ecosystems. Excess nitrates (greater than 50 mg/L) in drinking water converts haemoglobin to methemoglobin thus limiting transport and supply of oxygen in the body. This reduced supply of oxygen adversely affects various physiological processes [World Health Organization (WHO), 2008]. Siltation on neighboring aquatic ecosystems is accelerated by uncontrolled rates of soil erosion. Siltation in aquatic ecosystems lowers light penetration thus reducing primary productivity. The reduced primary productivity means reduced energy flow in the ecosystem. Some of the silt if carried to the ocean will reduce the growth of sensitive marine resources like coral reefs. Therefore soil loss must be addressed because the soil loss not only leads to food insecurity through reduced crop yields, but also degradation of aquatic ecosystems.

Mutegi *et al*. (2015) noted that with adoption of water and soil conservation hedges there would be improvement in soil quality which would enhance climate change resilience by agroecosystems. Environmentally, the increase of carbon pool in the soil and terrestrial biosphere as a result of adoption of soil and water conservation EFFPs. Other than their potential to prevent soil and water loss, agroforestry components (crops, shrubs and trees) in the course of their growth also sequester carbon, thus contributing to reduction of greenhouse gases and the resultant global warming. These EFFPs will not only ensure food security, but have great potential in mitigating the challenges of global warming.

3.2.3. Soil fertility practices

Soil fertility is central in agricultural production. Growing plants obtain varying amounts of nutrients from the soil. These nutrients in the soil can be exhausted if measures to replenish them are not adopted. However, natural processes (through nutrient cycles) partially replenish nutrients into the soil for use by plants. The deficit of the nutrients supplied by nature is supplied through addition of organic resources and / or inorganic fertilizers.

Soil fertility practices that are considered eco-friendly are composting, green manuring and cultivating leguminous plants. These practices are considered eco-friendly because they contribute to soil fertility by feeding the soil through improving the soil structure and improving the cation exchange capacity of the soils. Therefore, EFFPs on soil fertility measures are crucial in sustainable agroecosystems. Their central role and contribution is manifested through their wide adoption among households in Embu County. This medium intensity (of increased composting and green manuring) and high intensity adoption (of leguminous plants and crop rotation) confirms the relevance and the high ranking of the soil fertility. This high and medium intensity of adoption of soil fertility EFFPs is in tandem with earlier research findings (Njoroge, 2000; Njeru, 2015; Chomba, 2016). These studies ranked composting highly among the sustainable practices adopted by farmers.

Green manuring in Embu County was practiced by 61.4% of the sampled households. This is a markedly increase in adoption from what Onduru *et al.* (2002) had observed of 7% of the households had adopted green manuring in Eastern Kenya. Of the soil fertility EFFPs, composting is a major component because of the benefits it confers to the soils (Lampkin, 1994; Njoroge, 1999; and Njeru, 2015). Composting makes use of organic resources such as crop residues, weeds, farmyard manure and even carefully selected kitchen wastes (Opala and Nyongesa, 2007). These resources used in making compost manure, if left unattended in the environment, they would add to solid waste menace. Therefore composting as an ecofriendly farming practice is an important strategy of solid waste management by recycling organic wastes. Well composted manure not only provides nutrients necessary for crop growth, but also reduces wastes in the environment.

Despite the wide range of benefits associated with composting, some households (about a third) did not carry out composting despite appreciating the importance of composting. This low adoption and use of compost manure was also observed by Odendo *et al*. (2007) in Western Kenya (recording about 12%) in their study on adoption soil fertility management practices. This low adoption of this crucial practice could be explained by the challenges of competing needs in using organic resources (Jama *et al*., 1997) for composting. For instance maize stalks and other plant residues that would otherwise be used in composting are instead used as fodder for livestock. Similarly, the some woody crop residues that should be chopped and used in preparing compost manure are used as fuel. These multiple and competing needs reduce the availability of organic resources for composting. This is another reason why scarcity of the organic resources needed to produce enough crop residues and plant materials to meet crop nutrient demand, limits the preparation and use of compost manure. In addition, most of the available organic resources have low nutrients especially phosphorus (Woomer, *et al*., 1999; and Palm, *et al*., 2001). This means that households must carefully select the materials to use in composting because the choice of the input organic resources has to be wisely done to reap maximum benefits of compost manure.

KIOF (1999) and Lampkin (1994) observed good crop performance with the use of compost manure. With good crop performance realized from use of compost manure, reduced use of inorganic fertilizers will be inevitable. If there will be reduced use of inorganic fertilizers, the environmental challenges associated with excess fertilizers shall be reduced. Firstly, through the reduction of these inorganic fertilizers, the eutrophication in aquatic ecosystems will be minimized. Secondly, manufacture of inorganic fertilizers has been associated with emission of 0.6 Gt Carbon (IV) oxide equivalents (Verchot and Mutegi, 2007). Although, the inorganic fertilizers cannot be eliminated, because they play a pivotal role in supplementing crop nutrients, its manufacture uses exhaustible resources and the processes produces carbon (IV) oxide, a greenhouse gas. Therefore low use of these inorganic fertilizers on farms would keep these greenhouse gases emission at minimum.

One of the environmental effects of agriculture is the emission of greenhouse gases that have been associated with accelerated global warming. Global warming in its wide range of ripple environmental effects, in turn affects agriculture and man's livelihood. However, EFFPs especially composting can efficiently manage nitrogen and carbon in agroecosystems (Bouwman, 2001; and Clemens and Ahlgrimm, 2001). Improved compost management can reduce by more than a third of the methane gas and nitrous oxides (greenhouse gases) produced in anaerobic manure management (Verchot and Mutegi, 2007).

Given the limitations of organic resources, combining optimal use of inorganic fertilizers with compost manure, would be appropriate for most households. This is the approached advanced in integrated soil fertility management approaches and supported by Jama *et al*. (2011). Inorganic fertilizers and organic resources are complementary and therefore a combination of the two would give healthier and stronger crops than one single fertility techniques. The resulting healthier and bigger plants indicate that they will have sequestered more carbon from the atmosphere thus ensuring a more eco-friendly agroecosystem. If they are successfully and intensively adopted across several households, the potential of EFFPs in mitigating climate change in agroecosystems would be significant.

3.3. Influence of intensity on adoption of EFFPs

The study carried out further analysis to determine if a relationship exists between intensity of adoption and the EFFPs. The results are presented in Table 5.

Table 5: Intensity of adoption and Eco-Friendly Farming Practices in Embu County

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.309	4	0.989
Likelihood Ratio	0.318	4	0.989
Linear-by-Linear Association	0.005	1	0.945
N of Valid Cases	402		

A chi-square value of 0.309 with a corresponding *p*-value of 0.989 was obtained when the chi-square test was conducted to test for significance between intensity of adoption and EFFPs adopted. This *p*-value obtained is greater than 0.05 at 5% significance levels. Therefore, there is no statistically significant relationship between the intensity of adoption and the uptake of EFFPs among farming households of Embu County, Kenya.

These inconsistencies in the number of EFFPs adopted resonate with earlier adoption agricultural studies which have consistently shown that farmers do not necessarily adopt a full package of technologies even with intensified extension services. Risk aversions and lack of capital may contribute to this. Households therefore can adopt part(s) of the technology components or practice (Smale *et. al*., 1995). It is possible to find households that adopted some EFFPs without necessarily have been prompted by extension officers. Some household heads, for example bought or even inherited land that had water conservation structures and agroforestry species already on these pieces of land. Since they continue maintaining them, they were considered to have adopted.

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