I.J.S.N., VOL. 3(2) 2012: 251-258 ISSN 2229 – 6441

INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

www.scienceandnature.org

Review article

EFFECTS OF MARKET ACCESS AND RURAL SERVICES ON AGRICULTURAL LAND MANAGEMENT AND ADAPTATION TO CLIMATE CHANGE

[1]Adejobi, A.O. & [2]Babatunde, R.O.
[1]Department of Agricultural Economics, Obafemi Awolowo University, Ile-Ife, Nigeria.
[2]Department of Agricultural Economics and Farm Management, University of Ilorin, Nigeria.

ABSTRACT
Agricultural lands in the sub-Saharan Africa, which had hitherto been abundant, has continually been put under pressure in the last two decades or so due to competing needs for the lands for different developmental purposes. This, coupled with the prevalent climate change/variations has threatened the availability of land for Agricultural purposes viv-a-vis reduction in agricultural productivity, thereby putting the region at the risk of severe food insecurity. The study relied on the baseline data for the Nigerian Third National Irrigation Project (tagged Fadama III), which is an agricultural development programme and sponsored by the World Bank to determine the different kinds of land management strategies and adaptation strategies to mitigate climate change. The data were also used to model the market and rural service-related factors among others that affect adoption of sustainable land management and mitigation of climate change in the study area. The study revealed that majority (90.2%) of the households in the study area adopted one form of land management practice (SLM) and climate change mitigation method or the other. Use of inorganic fertilizer, mulching and ridging are the most widely practiced form of land management techniques. Generally, the adoption of different SLM and mitigation of climate change is relatively high in the study area because of the reduced precipitation and other climate variabilities associated with the savannah region where the study area lies. Furthermore, the results revealed that access to rural services and markets significantly affected adaptation to climate change and adoption of SLM practices. It is recommended that efforts aimed at improving rural services (such as distance to market, road, market information, number of contact with extension services and access to research services) should be intensified to ensure sustainable agricultural production, through the adoption of SLM practices and climate change mitigation methodds in the region.

KEYWORDS: Sustainable Land Management, Climate Change, Agricultural Productivity, Rural Services

INTRODUCTION

Climate change and land degradation are major threats to the survival and livelihoods of millions of people in sub-Saharan Africa (Cline 2007; Lobell *et al*., 2008). The scenario is aggravated by the over dependence of economies and peoples in the sub-region on rainfed agriculture, the prevalence of poverty and food insecurity, limited access to market and rural services in this region make coping with natural climate variability a recurring sore point (Yesuf *et al.*, 2008). Climate change has been associated with increased evapo transpiration, shorter growing periods, drying of the soil, increased pest and disease pressure, shifts in suitable areas for growing crops and livestock, and other problems for agriculture. Climate change is also expected to cause increased variability of rainfall (Kato *et al.,* 2009).

Literature has shown that many of the mitigation actions related to agriculture, forestry and land can also help people to adapt to climate change (Jindal *et al*., 2008; Bwalya *et al*., 2009; Kato *et al.,* 2009). For example, agro forestry activities can increase farmers' agricultural productivity and income security by improving soil fertility, reducing vulnerability to drought, and helping to diversify income sources, while also sequestering carbon. Water harvesting, soil and water conservation measures, conservation agriculture, organic soil fertility management and other sustainable land and water management practices can have similar income and resilience enhancing impacts, and would also increase carbon sequestration and thus reduce green house gas (GHG) emissions (Benin, 2006).

Therefore, the major challenge now is to redirect international, national and local efforts to promoting sustainable land management (SLM) and conserve biodiversity. This paper attempts to assess the level of awareness and adoption vis-à-vis the effect of access to markets and rural services on sustainable land management and climate change mitigation methods so as to achieve the potential opportunities through appropriate policy mix.

METHODOLOGY

Study Area

The study was conducted in the Federal Capital Territory (FCT) of Nigeria. The Federal Capital Territory has a total land area of 800,000 hectares, out of which 274,000 hectares are available for agricultural activities and 270,000 hectares under forest reserve. It has 93,092 farming families and a farming population of 446,506 based on the result last concluded household/Village Listing Survey of 2006. FCT consists of six Area Councils, which are equivalent of the State Local Government Area (LGA). The climate condition of the territory is favourable for the production of crops cultivated in both Northern and Southern part of the country. This is due to the fact that the territory constitutes a transition zone between a unimodal rainfall of the North and bimodal rainfall of the South. The relief of the FCT is relatively high with elevation ranging between 70m and 760m above sea level.

The relative humidity ranges from 2% during the dry season to 50% during the rainy season. The temperature ranges between 28^{o}C and 37^{o}C. However, the western part of the Territory has higher temperature and therefore, hotter than the Eastern part of the Territory due to the Niger-Benue Trough of the Eastern part. The mean annual rainfall is relatively high and ranges between 1145mm and 1632mm. The soil of FCT is mostly sandy-clay-loam and usually deep. It ranges from a well drained soil to alluvial deposits in the flood plain.

Sampling Technique

Multi-stage sampling technique was employed using Fadama beneficiaries as the primary sampling unit. As mentioned earlier the FCT is made up of six (6) local council areas which are further divided into ten Fadama Development Areas (FDA) for administrative convenience. In the first stage, all the six local council areas were purposively selected since they all benefited from Fadama II development project. The six local council areas are: Abuja Municipal, Kuje, Bwari, Kwali, Abaji and Gwagwalada. In the second stage, a random sampling technique was employed to select two Fadama Community Associations (FCA) from each FDA to give a total of twenty (20) FCAs. In the third stage, ten (10) respondents were randomly selected from all the constituting Fadama User Groups (FUG) in each FCA to give a total of two hundred respondents.

Analytical Technique

Determinants of Adoption Rates of Land Management Practices

The determinants of adoption rates of land management practices were modeled using the probit model. The econometric model used in determining the major drivers of adoption rates of land management practices among households in the study area is presented below:

Y = f {household level factors (formal credit, non-formal credit, membership of Fadama, Cooperative, Religious or Mutual groups, age of household head, adult male, adult female, female headship of households, remittances), value of productive assets, Number of livestock, Plot level factors (Irrigated hectarage, rainfed hectarage), years of formal education of household head, access to rural services (distances to market and road, access to market information, Number of contact with extension services, access to research services), cropping system (monocrop, intercrop) and Land tenure (Leasehold, rented plot, inheritance, borrowed, sharecrop)}

Implicitly, the model is stated as:

$$Y = f(HF, PA, LV, PF, ED, RS, CS, LT) \qquad 1$$

Where:

Y is the observed response for the ith repondent (i.e., the binary variable, Y_i= 1 for a household that adopts any of the sustainable land management practices and Y_i =0 if otherwise). The full description of variables in equation 1 is presented in Table 1.

TABLE 1: Description of Categories of Explanatory Variables

Variable	Definition
HF	Household level factors (formal credit, non-formal credit, membership of Fadama, Cooperative, Religious or Mutual groups, adult male, adult female, female headship of households, remittances)
PA	Value productive assets
LV	Number of livestock
PF	Plot level factors (Irrigated hectarage, rainfed hectarage)
ED	Years of formal education of household head
RS	Rural services (distance to market, road, have access to market information, Number of contact with extension services, access to research services)
CS	Cropping system (monocrop, intercrop)
LT	Land tenure (Leasehold, rented plot, inheritance, borrowed, sharecrop)

Determination of Adaptation to Climate Change

Adaptation to climate change in the study area was also modeled using the probit model. The variables captured and the model is as described below:

Implicitly, the model is stated as:

$$Y = f(HF, PA, LV, PF, ED, RS, CS, LT) \qquad 2$$

Where:

Y is the observed response for the ith repondent (i.e., the binary variable, Y_i= 1 for a household that adapts to climate change through any of the identified adaptation methods and Y_i =0 if otherwise). The full description of the various categories of explanatory variables is as explained in Table 1.

RESULTS

Land Management and Adaptation to Climate Change

Sustainable Land Management and mitigation of climate change are very important component of Agricultural production as these affect agricultural production variability. The adoption of various land management practices and methods of mitigating climate change are presented in Table 2.

TABLE 2: Land Management and Adaptation to Climate Change

Variable Name	Dominant Indicator	Mean	Standard Deviation
Use of manure	40.1% of households use manure	-	-
Fertilizer	97.6% of households use fertilizer	-	-
Fallowing	23.4% practice fallowing	-	-
Ridging	77.6% ridge their farmlands	-	-
Compost	33.5% use compost	-	-
Green Manure	10.1% use green manure	-	-
Mulching	87.6% practice mulching	-	-
Soil Bunds	0.0%	-	-
Improved Fallow	0.0%	-	-
Agro-forestry	37% plant trees on their farms	-	-
Adopt any form of Land Management Practice	90.2% use one form land management technique or the other	-	-

Source: Field Survey, 2009

From the table, it can be observed that majority (90.2%) of the households in the study area adopted one form of land management practice and climate change mitigation method or the other. Use of inorganic fertilizer, mulching and ridging are the most widely practiced form of land management. Generally, the adoption of different SLM and mitigation of climate change is relatively high in the study area because of the reduced precipitation and other climate variabilities associated with the savannah region where the study area lies.

Access to Other Rural Services

Rural services such as credit and availability of markets have been found to have tremendous impact on the livelihood of rural households (Scoones, 2000). The distribution of the services in the study area is presented in Table 3 below. From the table, there is generally high level of access to both formal and non-formal credit sources.

TABLE 3: Access to Other Rural Services

Variable Name	Dominant Indicator	Mean	Standard Deviation
Access to Formal Credit	76.3% had access to formal credit	-	-
Access to Non-Formal Credit	55.6% had access to non-formal credit	-	-
Value of Formal Credit	75% of the households took less than 20,000.00 from formal sources	9,500.00	83,678.15
Value of Non-Formal Credit	77% of the households took less than 5,000,00 from informal sources	468.18	3089.81
Distance to all Weather Roads	70.5% of the settlements are 5 Km or less to the nearest all weather road	4.80	8.71
Distance to Major Urban Center	55.4% of the settlements are 10 Km or less to major urban centers	10.28	6.71
Distance to nearest Market	27.7% of the settlements are 10 Km or more to the nearest market.	7.18	6.50
Market Information	72.3% of the households had access to market information	-	-
Access to Extension Services	87.7% had no access to extension services	-	-

Source: Field survey, 2009

This portrays good potentials for credit support in the study area and should be leveraged upon to further promote household livelihood under the project. Other rural services investigated and reported in Table 3 are well distributed in the study area. The average distances to the nearest urban centers, markets and all weather roads are 10.28, 7.18 and 4.80 respectively. There is also a high rate of access to extension services in the study area. These results are expected as all the LGAs in the study area participated in Fadama II and most of these services were emphasized.

However, these should be improved upon as they are essential to the ensure market access and improved rural services in the study area.

Determinants of Adoption Rates of Land Management Practices

The determinants of adoption rates of land management practices were also modeled using the probit model. The econometric model used in determining the major drivers of adoption rates of land management practices among households in the study area is presented in equation 1. The result from the probit model is presented in Table 4.

TABLE 4: Probit Models for Adoption of Various Sustainable Land Management Practices

Variable	Fertilizer	Animal manure	Compost	Fallowing	Ridges	mulching	Agro-forestry
Formal credit	0.011**	0.003*	0.037**	0.123	-0.112	0.106**	0.831**
	(2.970)	(1.782)	(1.934)	(0.938)	(-0.197)	(2.341)	(4.237)
Non formal credit	0.009	0.215	0.022	-0.444	-0.512	-0.607	0.041
	(1.012)	(0.976)	(1.011)	(-1.009)	(-0.776)	(-0.998)	(1.000)
Member cooperative societies	0.051**	0.001	-0.910*	-0.733	-0.102	0.901	0.152**
	(2.356)	(0.992)	(1.876)	(-0.778)	(-0.665)	(0.879)	(3.419)
Member religious organization	1.003	0.319	0.704	0.218	0.007	1.113	-0.603
	(1.112)	(0.982)	(1.001)	(0.870)	(0.867)	(0.773)	(0.974)
Member mutual group	0.070	-0.135	0.178	0.008	0.369**	0.078	0.183
	(0.808)	(-0.86)	(1.100)	(0.098)	(3.665)	(1.021)	(0.911)
Age of household head	-0.307	-0.025	-0.013	-0.491**	0.409**	-0.239**	-0.207*
	(-0.321)	(-0.92)	(-1.02)	(-3.762)	(2.900)	(-3.21)	(-1.992)
Adult male	-0.004	-0.322	0.750	0.395	-0.112	-0.101	0.185
	(0.675)	(-0.91)	(1.000)	(0.667)	(-0.653)	(-0.765)	(0.997)
Adult female	0.380	-0.616	-0.045	0.178	0.001	-0.181	0.096
	(0.746)	(-0.87)	(-0.43)	(0.333)	(0.211)	(-0.888)	(0.119)
Female household head	-0.123**	-0.023	0.022	-0.317	0.017	-0.501	-0.231
	(-3.11)	(-0.11)	(0.334)	(-0.777)	(0.09)	(-0.765)	(-0.556)
Remittance	-0.046*	0.29**	-0.008	0.645	-0.268	0.422**	-0.222
	(-2.88)	(3.12)	(0.998)	(1.00)	(-0.99)	(4.10)	(-0.887)
Value of productive assets	0.012**	0.26**	0.118**	-0.027	0.064**	0.454**	-0.221
	(3.110)	(2.991)	(3.33)	(-0.922)	(2.99)	(3.221)	(-0.554)
Total livestock unit	0.02	0.41**	0.051**	-0.413	-0.910	0.009	-0.149
	(0.977)	(2.03)	(2.88)	(-0.882)	(-1.10)	(0.087)	(-0.577)
Irrigated hectarage	0.413**	0.119**	-0.211	0.072	-0.255	-0.004	-0.153*
	(2.776)	(3.11)	(-1.11)	(0.332)	(-0.776)	(-0.676)	(1.99)
Rainfed hectarage	-0.065**	-0.026	-0.046	-0.130*	-0.334**	0.018	0.116**
	(-3.01)	(-0.77)	(-.560)	(-1.78)	(-2.98)	(0.868)	(2.778)
Years of schooling	0.076	0.21**	-0.179**	-0.354	0.25	-0.463**	0.298
	(0.776)	(3.10)	(-2.22)	(-0.75)	(0.213)	(4.12)	(1.00)
Leasehold	0.382**	0.49**	-0.532	-0.312*	-0.149	-0.311*	0.009
	(3.419)	(2.99)	(-0.90)	(-1.99)	(-0.098)	(-1.88)	(0.765)
Inheritance	0.311**	0.20**	-0.237*	0.338**	-0.406**	0.429	-0.291
	(2.11)	(3.01)	(-1.97)	(2.55)	(-3.35)	(0.997)	(-1.34)
Rent	0.207**	0.103*	0.383	-0.115	-0.441**	-0.043	-0.497**
	(2.66)	(1.89)	(0.822)	(-0.009)	(3.91)	(1.01)	(-4.19)
Borrowed	0.226	0.117	-0.416	0.221	0.372	0.008	-0.573
	(0.77)	(0.119)	(-1.08)	(0.419)	(0.775)	(0.919)	(-1.02)
Sharecrop	-0.260*	-0.238	0.041	0.761	-0.008	0.312*	0.198
	(-1.79)	(-0.97)	(0.091)	(0.876)	(-0.011)	(1.78)	(0.543)
Mono crop	1.13	-0.912	-0.270	0.006	0.235	0.770	-0.198
	(1.29)	(1.07)	(-0.776)	(0.82)	(0.615)	(0.942)	(-0.765)
Intercrop	1.04	0.550	-0.119	0.672	-0.607	0.423	0.116
	(1.34)	(0.444)	(-0.211)	(0.776)	(-0.707)	(0.888)	(0.453)

Variable	Fertilizer	Animal manure	Compost	Fallowing	Ridges	mulching	Agro-forestry
Market information	-0.009	0.89**	0.49*	0.236	-0.057	0.419	0.474**
	(0.122)	(2.33)	(1.78)	(0.816)	(-0.621)	(0.976)	(3.19)
	0.217**	0.11**	-0.707	-0.212	0.019	0.714**	0.702**
Extension	(2.99)	(2.09)	(0.911)	(-0.719)	(0.203)	(3.149)	(2.77)
Distance to market	-0.111**	-0.114	-0.009	-0.419	0.104	0.004	-0.216
	(-3.331)	(-1.08)	(0.776)	(-0.667)	(0.605)	(0.417)	(-0.555)
Distance to all-weather road	0.212**	0.312	-0.112	0.033	-0.114	-0.117**	-0.079**
	(3.11)	(0.778)	(-0.443)	(0.652)	(-0.766)	(-3.99)	(2.222)

Source: Computer printout of data analysis. ** Significant at 1%; * at 5%. Figures in parenthesis are t-values.

Table 4 shows that 7 different probit models were run for the different SLMs including: mulching, agroforestry, ridges and fallowing. Others are manure use, fertilizer and compost. Each of the models are interpreted as follows:

Mulching

The Probit model for mulching as reported in Table 4 revealed that coefficients of only nine of the conceptualized variables were significant. These variables are formal credit, age of head of household, value of remittance received and value of productive assets. Others include: years of formal education of household head, leasehold, share crop and access to extension agents. The table shows that increasing values of formal credit, productive assets and remittances are positive drivers of adoption of mulching technology as a mean of sustainable land management while increasing age and years of formal education of household head tend to reduce the probability of adopting mulching. Increasing distance to all weather roads reduce the probability of adopting mulching, this may have to do with difficulty of transporting the mulching materials. Households who practice land tenure other than leasehold, practice sharecropping with higher number of extension contacts have higher probabilities of adopting mulching

Agro-forestry

From Table 4, it could be deduced that the coefficients of nine of the variables in the Probit model for Agroforestry are significant. The variable include: formal credit, membership of cooperative societies, age of the head of household, irrigated and rainfed hectarage. Other variables whose coefficients are significant include rent, market information, extension and distance to all weather road. The positive sign on the coefficients for values of formal credit and rainfed hectarage suggests that increasing values of these variables will increase the probability of adopting mulching as a sustainable land management practice. Further to this, households headed by younger people and whose heads are members of cooperative societies have higher probabilities of adopting mulching. Interestingly, the higher the hectarage put under irrigation by households is, the lower the probability of adopting mulching. This is plausible as mulching is a water-conservation technique and irrigation supplies water as such no need for mulching. Households far away from all weather roads and cultivate on rented lands have lower probability of adopting mulching. However, access to more extension contacts and market information increase the probability of adopting mulching as a sustainable land management practice.

Ridges

The Probit model for ridges as reported in Table 4 revealed that coefficients of only six of the conceptualized variables were significant. These variables are membership of mutual group, age of household head, value of productive assets, rainfed hectarage, inheritance and rent. Membership of mutual group is a significant factor that affects adoption of ridges as a sustainable land management method in the study area. Households whose heads are member of mutual groups have higher probability of adopting ridges as SLM. This is in conformity with a priori expectation in that mutual grouping is a common factor in the area and one of the key activities the groups help members to do is land preparation, which includes ridging. Further to this, older household heads still prefer to using ridges as SLM in the study area as it is an age-long practice. Due to the capital intensive nature of the method, increasing value of productive assets increases the probability of using ridges as a SLM. Finally, lower shares of household farm holdings rented or inherited increase the probability of using ridging as a SLM in the study area.

Fallowing

Fallowing is an old method of land management. It involves the abandonment of a farmland, which had hitherto being used for farming for some years for a fresh land considered to be fertile. This system puts a lot of pressure on land and is almost out of fashion as a SLM. The model capturing the adoption of fallowing is reported in Table 4. The Probit model for fallowing as reported in the table revealed that coefficients of only four of the conceptualized variables were significant. These variables include: Age of household head, rainfed hectarage, leasehold and inheritance. The estimate of the coefficient of age of head of household reflects tha younger heads of households have higher probability of adopting fallowing as a SLM. Households that practice leasehold with higher share of the farmland under rainfed system have lower probabilities of adopting fallowing. However, households who inherited lands have higher probabilities of adopting fallowing. The area of interest here for Fadama III is that land holding/tenure is a very strong driver of adoption of any type of sustainable land management practice.

Animal Manure

The model capturing the adoption of animal manure is reported in Table 4. The Probit model for animal manure as reported in the table revealed that coefficients of eleven of the conceptualized variables were significant. The variable include: formal credit, remittances value of productive assets, total livestock unit and irrigated hectarage. Other variable with significant coefficients in the model are years of formal education of household head, leasehold, inheritance, rent, market information, and extension contacts. From the result, the coefficients of formal credit, values of remittances, total livestock units and irrigated hectarage are positive, implying that increasing values of these variables increase the probability of adopting animal manure as a sustainable land management practice. Further to this, household heads with higher levels of education have higher probability of adopting the use of animal manure. This is in line with a priori expectation that education is a major driver of innovations.

From the result of the model three different land tenure systems affected the adoption of animal manure. These include leasehold, inheritance and rent. The coefficients of these variables are positive, suggesting that households with these types of land tenure have higher probability of adopting the use of animal manure. This further underlies the importance of land tenure in the adoption and use of the different types of land management practices in the study area. Access to rural service (Market information and extension contacts) is also a strong driver of adoption of manure use. The positive sign on the coefficients of these variables signifies that households with access to market information and extension services have higher probability of adopting animal manure as a sustainable land management practice.

TABLE 5: Probit Model Estimates for Adaptation to Climate Change

Variable	Parameter Estimate	t-value
Formal credit	0.101**	2.230
Non formal credit	-0.125	-0.981
Member cooperative societies	-0.136	0.760
Member religious organization	-0.133	0.324
Member mutual group	0.146**	3.451
Age of household head	-0.111**	3.212
Adult male	-0.128	-0.781
Adult female	-0.183	-0.993
Female household head	-0.123	-0.818
Remittance	0.187	0.772
Value of productive assets	0.007*	1.973
Total livestock unit	-0.097	-0.515
Irrigated hectarage	-0.117	-0.419
Rainfed hectarage	-0.005	-0.865
Years of formal education of household head	0.156**	2.771
Leasehold	-0.195	0.533
Inheritance	0.005*	1.725
Rent	-0.135	-0.393
Borrowed	-0.012	-0.702
Sharecrop	-0.137	-0.817
Mono crop	-0.157	-1.01
Intercrop	-0.116	-0.443
Market information	0.133**	2.423
Extension	0.185**	3.210
Distance to market	-0.129	-0.613
Distance to all-weather road	0.418	0.537

Source: Computer printout of data analysis. ** Significant at 1%; * at 5%.

Fertilizer

From the previous section, this is the most commonly adopted land management practice in the study area. The Probit model for the adoption of fertilizer is reported in Table 4. From the table, fourteen variables had their coefficients significant. These variables include: formal credit, membership of cooperative societies, female household head, remittances, value of productive assets, irrigated and rainfed hectarages. Others are leasehold, inheritance, rent, sharecrop, extension, distance to the market and distance to all weather road. This implies that household level factors, cropping system and land tenure system are strong drivers of adoption and use of fertilizer. Other drivers are access to rural services, values of productive assets and farm areas under irrigation and rainfed farming.

Compost

The use of compost is one of the least adopted sustainable land management practice as shown in the previous section. The Probit model for compost as reported in Table 4 revealed that coefficients of only seven of the conceptualized variables were significant. The variables whose coefficients are significant are formal credit, membership of cooperative societies, value of productive assets and total livestock unit. Others include years of formal education of household head, inheritance and access to market information. The coefficients of formal credit, value of productive assets and total livestock unit are positive and this suggests that higher values of these variables signify higher probability of adopting compost as a sustainable land management practice. Further to this, higher level of education of household heads and membership of cooperative societies reduce the probability of adopting use of compost. Land tenure system other than inheritance and access to market information increase the probability of adoption of compost in the study area.

Determinants of Adaptation to Climate Change

Adaptation to climate change in the study area was modeled using the Probit model. The variables captured and the model is as described in Table 1:

Implicitly, the model is stated as:

$$Y = f\,(HF, PA, LV, PF, ED, RS, CS, LT) \qquad 3$$

Where:

Y is the observed response for the i^{th} repondent (i.e., the binary variable, Y_i= 1 for a household that adapts to climate change through any of the identified adaptation methods and Y_i =0 if otherwise). The result of the probit model is presented in Table 5.

From the table, only eight of the variables captured in the model had their coefficients significant at between 1% and 5%. The variables include: formal credit, mutual group, age of household head and value of productive assets. Other variables are years of formal education of household head, inheritance, market information and extension.

The coefficients of the values of formal credit and household productive assets are positive, suggesting that increasing values of these variables have higher propensity on household adaptation to climate change. This shows that wealth of the households is a major driver in adaptation to climate change. Any investment to boost household wealth is in the right direction if the households are to embrace climate change. As expected, younger household heads with higher levels of education had higher probability of adapting to climate change than the older household heads. Further to these, mutual grouping, access to market information and extension contacts also positively affect adaptation to climate change. This shows that changes resulting from adaptation to climate change are technology driven and this requires information and training. Strategies of investing on extension and information delivery will be in the right direction in the study area.

CONCLUSION AND RECOMMENDATIONS

In conclusion, ownership of productive assets greatly influenced the adaptation to climate change and adoption of SLM practices in the study area. Access to rural services also affected SLM practices and adaptation to climate change. Specifically, proximity to roads greatly influenced adaptation to climate change using sustainable land management (SLM) practices and adoption of agroforestry.

Further to the foregoing, access to extension or market information increase households' capacity for adoption of SLM practices and probability of adapting to climate change. Likewise, this study further revealed that SLM practices increase crop productivity and are used for adaptation to climate change. It was noticed that their adoption rates is relatively high in the study area. Therefore, there is need to evolve a multidisciplinary approach in sustaining and promoting this component, particularly provision of extension services to provide advisory services and necessary skills on SLM practices and this will increase their adoption rates in the FCT.

In summary, the study revealed that the various components and sub-components of Fadama III relating to market access and provision of rural services affected the adoption of SLM techniques and adaptation to climate change. These in turn are found to have significant effects on agricultural productivity vis-a-vis poverty reduction and food security. It is therefore strongly recommended that the various components and sub-components that can promoting market access and improved access to rural servvices be vigorously pursued.

ACKNOWLEDGEMENTS

We appreciate the contribution and support of the State Project Coordinator (SPC) for Fadama III in the FCT in the areas of logistic for this study. The Efforts of the Monitoring and Evaluation Officer (M&E) and his team in identifying, training and recruitment of Enumerators and data entry clerks are unprecedented. We also wish to acknowledge the support of our Research Assistants in the persons of Mr. Dele Akinwole, Mr Dare Alabi and Miss Angela Alexander as well as others in the FCT Fadama Office that we cannot mention here.

REFERENCES

Benin, S. (2006) Policies and programs affecting land management practices, input use and productivity in the highlands of Amhara region, Ethiopia in Pender, Place, and Ehui

(eds) Strategies for Sustainable Land Management in the East African Highlands, World Bank and International Food Policy Research Institute, Washington, DC.

Bwalya, M., E. Phiri, H. Mahalmoudou, and A. A. Diallo. (2009) The Comprehensive Africa Agriculture Development Programme (CAADP). Sustainable Land Water Management. Midrand, South Africa: NEPAD.

Cline, W. (2007) Global Warming and Agriculture: Impact Estimates by Country. Washington, DC: Peterson Institute.

Jindal, R., B. Swallow and J. Kerr. (2008) Forestry-based carbon sequestration projects in Africa: potential benefits and challenges. Natural Resources Forum 32: 116-130.

Kato, E., C. Ringler, M. Yusuf and E. Bryan. (2009) Evaluation of adaptations to climate change: Analysis of the risk increasing and risk reducing effects of soil conservation technologies in low and high rainfall woredas of Ethiopia. International Food Policy Research Institute, Washington, D.C. Mimeo.

Lobell, D. B., M. B. Burke, C. Tebaldi, M. D. Mastrandrea, W. P. Falcon, and R. L. Naylor (2008) Prioritizing climate change adaptation needs for food security in 2030. *Science*, 319 (5863): 607-610.

Scoones, I. (2000) Sustainable Rural Livelihoods; A Framework for Analysis. *IDS Working Paper 72.*

Yesuf, M., S. Di Falco, T. Deressa, C. Ringler and G. Kohlin. (2008) The impact of climate change and adaptation on food production in low-income countries: evidence from the Nile Basin, Ethiopia. IFPRI Discussion Paper 828, International Food Policy Research Institute, Washington, D.C.