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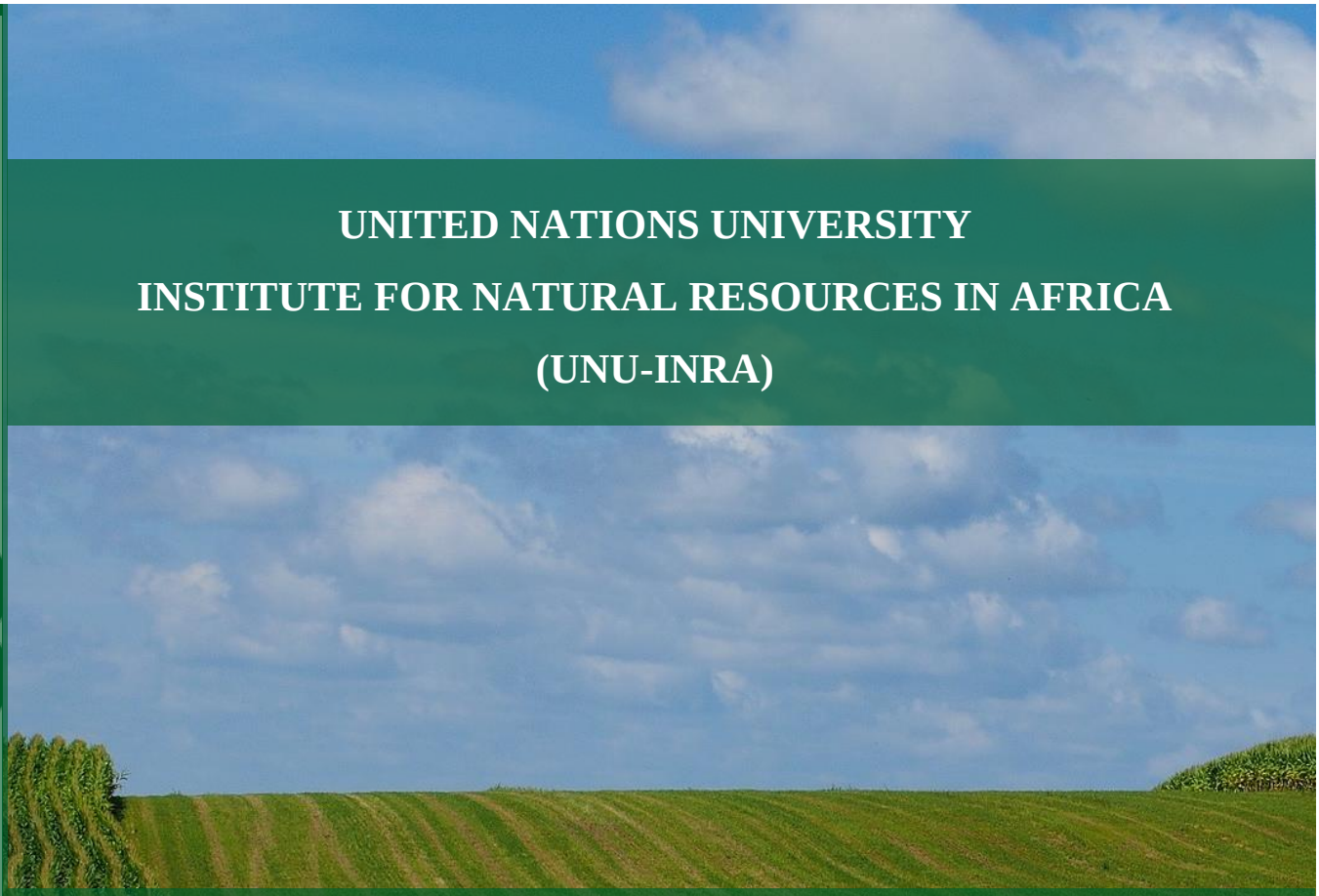

FEASIBILITY OF GREEN CREDIT AS AN INCENTIVE FOR NATURAL RESOURCE MANAGEMENT IN KENYA

OBADIAH H. NGIGI

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BY

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ABSTRACT

The greatest challenge smallholder farm enterprises in Kenya face is soil degradation through soil erosion. Past command and control approaches as well as other incentive-based approaches have focused on downstream interests, while ignoring the value of good soil management practice as a business operation within the farming enterprise. Farmers could potentially benefit from improved soil conservation and therefore ensure sustainable productivity of their soil asset. Despite the interest in soil conservation practices, they cannot afford initial costs and sometimes lack technical knowledge requisite for establishing the appropriate technologies. Existing credit service providers do not consider soil as an asset and do not have provisions for supporting its conservation. Additionally, smallholder farmers lack incentives to invest in sustainable agricultural practices. Appropriately designed green credit can provide both incentive and impetus for farmers to invest in sustainable soil and water management practices, which reduce soil erosion and in the long run ensure restoration of soil fertility and land productivity. This feasibility study was conducted to determine the demand for environmental conditional credit and the factors affecting farmers demand for it. Contingent valuation method was used to estimate the demand and factors affecting green credit. Results obtained from a survey of 100 smallholder farmers reveal that there is demand for environmental conditional credit among smallholder farmers in Kenya and that green credit can be a strong incentive for behavior change towards natural resource management. The study recommends the establishment of a fund for environmental lending to improve ecosystem-based adaptation.

Key words: Farmers, conservation, sustainable finance, green credit, Kenya

1.0 INTRODUCTION

Soil is one of the most important resources influencing agricultural production in Kenya (GoK, 2007b). However, soil degradation remains a major environmental threat to the sustainability and productive capacity of agriculture. Globally, about 10 million hectares of crop land are lost each year due to soil erosion thus reducing the crop land available for food production (Pimentel, 2006). In Kenya, soil and water management is therefore a strategic requirement for economic growth because it creates the basis for local food production and agricultural exports (GoK, 2007b). Over the years, the government has promulgated a set of policy interventions towards sustainable soil and water use. Nevertheless, there are diverse challenges and constraints including encroachment and subsequent conversion of fragile lands to farmland by the poor (GoK, 2007b). As a result, this has led to increased vulnerability and aggravated soil degradation to the extent that the affected poor farmers are barely able to meet their subsistence needs (Murali, 2006).

Sasumua sub-catchment has experienced high pressure on the soil resource base due to cultivation on very steep slopes and along river banks (Gathenya *et al.,* 2009). These changes in land use are a major cause of low productivity in the area, drying up of some streams in the catchment, loading of sediment in rivers during the rainy season and subsequent loss of aquatic fauna and flora. In addition, it poses significant costs to urban water treatment especially, to the utility supplier as about 20% of the water supply for Nairobi city originates from the catchment.

Soil and water conservation measures have proved efficient in restoring degraded soils. Where soil and water conservation measures have been employed in Kenya, research shows crop yield increases of 12% within one year (Mwangi *et al.,* 2001) whilst other research within sub-Saharan Africa shows loss of viable soil fertility within 20 years where no measures are employed (Stocking, 2006).

There are two documented approaches for preventing or reversing soil and water resource degradation. The first is through regulation and prohibition often termed “command and control” (Wunder *et al.,* 2008) which places the burden of funding conservation on land owners. Such an approach is difficult to enforce in developing countries due to institutional shortcomings, weak governance structures and a moral obligation on governments not to hurt the poor. This

makes it politically unfeasible to implement (Swallow *et al.,* 2007). The other approach is incentive-based (FAO, 2001) where land owners practicing "good land use practices" that protect or enhance ecosystem services are rewarded (Wunder, 2005; Swallow *et al.,* 2007). This mechanism is a response to failure of the command and control approach and has potential to enhance environmental conservation and improve rural livelihoods.

Incentive-based approaches are effective in ensuring sustainable use of natural resources in productive activities (Van Noordwijk & Leimona 2010), but has not worked well in developing countries due to lack of proper guiding principles and lack of clear framework for the payment of rewards (Mwangi *et al.,*2012). In addition, the beneficiaries of environmental services view the rewards as a burden.

Agricultural credit has the potential of increasing agricultural productivity (Saleem & Jan, 2011) and capacity to support soil and water conservation by shifting from the extensive use of natural resources to sustainable management in the long run (Murali, 2006). Additionally, credit can be an incentive to invest in the rehabilitation of degraded soils and maintenance of soil and water capacity to supply ecosystem services. However, smallholder farmers in Kenya have limited or no capacity to access credit from formal financial institutions (Ellis *et al.,* 2010). Furthermore, financial institutions provide credit to smallholder farmers without offering help to invest in protecting their soils – a productive asset on which they depend. This is likely to reduce smallholder farmers' credit repayment ability and negatively impact on their bankability.

No study has ever been undertaken to determine the demand for credit with environmental condition. Therefore, there is no such literature. This study therefore seeks to determine whether there is demand for environmental conditional credit (green credit) as an incentive for natural resource management in Kenya. The study responds to the following research questions;

1. Is there demand for credit as an incentive to soil and water conservation among smallholder farmers in Sasumua watershed in Kenya?
2. What factors influence demand for an environmental conditional credit among smallholder farmers in Sasumua watershed in Kenya?

2.0 LITERATURE REVIEW

2.1 Studies on soil erosion and its effects on crop production

Soil degradation is a major environmental threat to the sustainability and productive capacity of agriculture globally (Stocking, 2003). During the last 60 years, nearly one third of the world's arable land has been lost due to soil erosion and continues to be lost at a rate of more than 10 million hectares per year (Pimental, 2006). According to FAO (2001) and Stocking (2003), the reduction in soil productivity as a result of unsustainable farming practices leads to lower crop yields in the short run, and constitutes mining of the soil resource and a loss of national wealth.

Natural resource degradation can lead to situations where the poor emerge as the principal users of degraded farm land (Murali, 2006; Sanginga & Woomer, 2009). This is due to the lack of alternative economic activities and a very low opportunity cost of labour in comparison with the rich. In addition, Stocking (2003) pointed that soil erosion is the driver of a number of critical environmental, economic and social issues in both developing and developed countries. Therefore, soil erosion has implications on quality, resilience, fertility, plant nutrients, crop yield, and subsequently farmer livelihoods (Stocking, 2003; Mwangi *et al.*, 2012; Pimental, 2006; Sanginga & Woomer, 2009).

2.2 Incentives to soil and water management

The starting point to proper soil and water management is the farmers' recognition and awareness of the problem of soil degradation (FAO 2001). If farmers do not perceive a problem, they will have little inclination to improve their soil management. According to (Sanginga & Woomer, 2009), improving agricultural productivity for small scale farmers in Africa, requires a combination of approaches such as organic and inorganic fertilizer use, conservation agriculture, capacity building, marketing support and gender empowerment. Their recommended approach, however, lacks the incentive to catalyze the farmers to integrate the approaches to foster sustainable farm productivity. Murali (2006) noted that one of the most effective means to ensure enhanced economic gains from natural assets is internalization of the benefits from efficient management of that resource. Further, the interventions should offer some economic

benefits such as subsidies, soft loans, encouragement for local specific resource mobilization, microcredit schemes.

2.3 Payment for Ecosystem services

Wunder (2005) defined Payment for Ecosystem Services as a voluntary transaction in which a well-defined environmental service is bought by at least one environmental services buyer from a minimum of one environmental services provider if and only if the provider continues to supply that service. The above conditions limit the applicability of pure PES form. There is a wide range of PES-like arrangements according to Wunder (2008), which vary in the type of incentive, the degree of voluntariness in buyers and sellers, the rights to sell and rights to buy, the degree of negotiation of the transaction, clarity on what environmental services is provided and the way conditionality is operationalized.

Noordwijk & Leimona (2010)'s definition of PES recognizes three 'principles' namely realistic, conditional and voluntary characteristics. PES in its pure form may appear to link a financial flow to a flow of services derived from natural capital. Based on the conditionality of PES, three paradigms representing processes that enhance environmental services can be derived-Commoditized environmental service (CES), which is based on actual service delivery and direct marketability, Compensation for opportunities skipped" (COS), or paying land users for accepting restrictions (either voluntary or mandatory) on their use of land and "Co-investment in stewardship" (CIS) of landscapes for enhancing environmental services. This study seeks to utilize and modify the "Co-investment in stewardship" (CIS) approach. The intention is to improve the farmer's capability to utilize their physical, natural and social capital by capacitating their financial and human capitals to deliver the ecosystem services desired. The study further seeks to use microfinance approach on private farms compared to public or state land commonly referred to in that approach.

According to Forest (2008), there are a range of limiting conditions, which currently inhibit the widespread application of PES in rural communities including the lack of sustainable financial resources associated with PES. This study addresses this problem by exploring the feasibility of a sustainable financial incentive mechanism to the provision of environmental services at

the household and watershed levels. The mechanism can be expected to improve farmer well-being.

2.4 Credit as incentive for soil and water management

Mohammed & Jan (2011) concluded that the availability of credit was associated with increased agricultural production and gross domestic product (GDP) in Pakistan. Furthermore, 80% of the impact on GDP was attributed to the use, by farmers, of credit facilities for seed and fertilizers. They also found a strong correlation between credit for seed and fertilizers alongside pesticides, irrigation and tractors. FAO (2001) revealed that there are many economic actions which involve establishing appropriate incentives for improved soil management at the farm level, which make rational farmers employ such models for farm-level soil management. They recommended an approach that is integrative and participatory involving credit assistance to finance on-farm structures, improvement in extension and farmer training programmes. This is the model that this study seeks to develop.

Murali (2006) identified the weaknesses linked to the use of credit, specifically for the purchase of external inputs. Negative impacts include pollution from pesticides and fertilizers and encroachment onto virgin lands resulting in increased deforestation and habitat loss. Increased cattle-grazing and animal husbandry is facilitated since a significant amount of rural credit is used to purchase cattle. He recommended that micro entrepreneurs should seek out incentives that have both environmental and economic benefits that will encourage improved environmental practices among the beneficiaries. This is the approach the study seeks to adopt by integrating agricultural credit to incentivize farmers to conserve soil and water alongside the economic benefit.

Pande *et al.* (2011) in their study to investigate incentives for soil and water conservation in Gugarat, India examined direct incentives like input subsidies, supply of farm implements and tools, drought relief programmes, wages, employment programmes and indirect incentives such as output price, access to markets, credit facility and extension services offered by the state to marginal farms. Results showed that financial inclusion could be a good incentive for soil and water conservation. They recommended designing a loan with easier terms and condi-

tions for land management for small and marginal farms. This is what this study seeks to design and investigate.

2.5 Contingent Valuation Method (CVM) in estimating WTP

Contingent valuation method (CVM) is a survey-based method to elicit individuals' valuation of goods and services not sold in the market place, by calculating their willingness to pay (WTP). Contingent valuation method was pioneered by Bishop and Heberlein (1979). Contingent valuation method with dichotomous choice studies and a follow-up question has recently been used. This is because of the generally accepted view that the method gives more efficient results (Hanemann *et al*., 1991). Li *et al*. (2003) conducted a survey in Beijing, China to determine consumer attitudes towards GM foods using the double-bounded logit model.

McCluskey *et al*. (2001) sought to estimate willingness to pay for GM-free food products and analyse the factors that induce Japanese consumers to choose GM-free food products. They built a double-bounded logit model, and from it developed a "semi-double-bounded" logit model, in that those individuals who responded with a yes to the first question (implying that they were willing to purchase the GM food product at no discount) were not asked a follow-up question because of the nature of the product.

Kaneko & Chern (2003) used dichotomous choice-based CV to determine willingness to pay for non-GM vegetable oil, salmon fillets and cornflakes. This study will use a double-bounded logit model to estimate WTP unlike the binomial logit, as the latter is better placed to capture the advantage of using a follow-up question.

Hanemann *et al*. (1991) conducted a survey on WTP for protecting wildlife and wetland habitat in California's San Joaquin Valley. They used mail-out questionnaires to collect the responses to the initial bids, and a telephone interview to collect the responses to the follow-up bids. Estimation of the WTP was done using both the single- and double-bounded logit models. Comparing the two, they observed that coefficients from double-bounded model were asymptotically more efficient than those from single-bounded model and yields tighter confidence intervals and lower point estimates for mean WTP.

Kimenju & De Groote (2008) conducted a survey in Nairobi, Kenya to gauge consumers' awareness of GM foods, their WTP for GM foods and factors that influence their WTP. They estimated willingness to pay using double-bound logit dichotomous choice model based on CV method. Keter (2007) used double-bound logit dichotomous choice model based on CV method to assess rural western Kenya's consumer's awareness, attitude and willingness to pay for genetically modified food. The difference arises from the fact that: (i) data will be collected from farmers in a rural set-up rather than urban consumers. (ii) this study focuses on natural resources rather than consumer goods. The set-up is based on action research compared to previous studies.

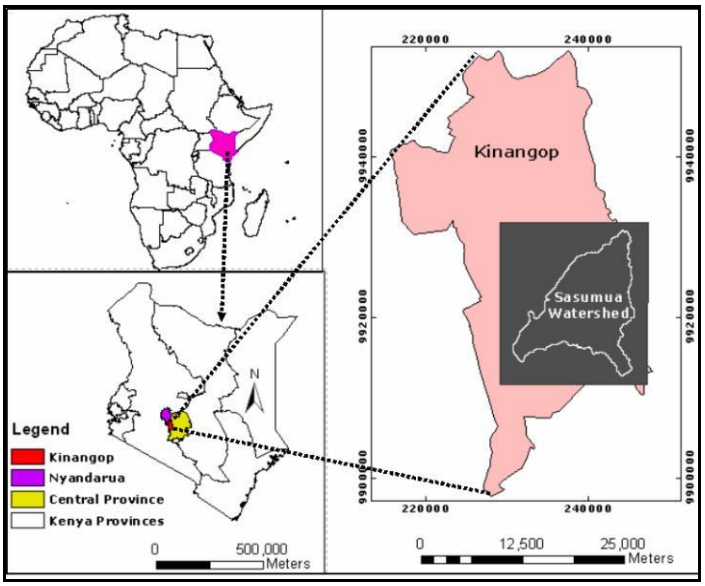
To overcome and eliminate the problem of hypothetical bias using the Contingent Valuation Method, where respondents state their preferences without any direct financial implications (Qaim, 2009), this study used participatory action research. In this context, interested farmers were introduced to the green credit scheme and were given collateral free credit tied to environmental conditions. Farmers who had accessed environmental conditional credit were required to implement soil and water management practices. They also had adequate information on the green credit scheme and were later asked to talk about their preferences through personal interviews.

3.0 MATERIALS AND METHODS

3.1 Study area

The Sasumua watershed lies in the Southern part of the Aberdares in Central Kenya. The population is high with a growth rate of approximately 3.6% per annum. The topography of Sasumua watershed is characterized by steep slopes in the northern forested part of the watershed bordering the Aberdares National Park and along the lower banks of major rivers that drain into Sasumua reservoir. The total catchment area feeding the reservoir is 107 km^2 about half of which is in the forest reserve. Sasumua provides about 20% of potable water to supplement the water supply for Nairobi city. Nearly 75% of the watershed is intensively cultivated on parcels of land averaging 1.16 ha per household. The watershed is mainly dominated by horticultural production and rearing of dairy cattle. These products find a ready market in Nairobi and on the export market.

Figure 1: Location of Sasumua Sub-watershed



3.2 Green credit scheme modeling

To inform the green credit scheme modeling, focus group discussions were held in five villages in the study area involving 5-7 members per group. Participants were purposively and randomly selected from farmer groups and included active farmers and leaders of farmer groups, both men and women. Selection was purposive because we wanted critical review and feedback for the purpose of modeling the scheme. The discussion included financial sector trend analysis, seasonality of credit needs, credit product attributes and ranking,

Table 1. Green credit need assessment results

Research area	Objective	Results	Observations	Opportunities for green credit
Financial sector trend analysis	*To learn where farmers obtained agricultural financial services in the area and the changes over time*	• SACCOS dominated • Few mobile banks • Group saving and Loans • MFIs • Table banking • Merry-go-round	• Mainstream banks are coming up • SACCOS serve target farmer groups • Terms and conditions of MFIs not liked by farmers	• There is need for green credit among farmers • Technical training as value addition to credit is valuable • Specific tar-

			• No extension services to farmers	get to farmers willing to invest in soil and water conservation
Seasonality of credit needs	*To identify which months of the year farmers critically needed agricultural loan, reasons and sources of loans*	January-February, May and October are critical months for agricultural credit needs	Credit was obtained from various sources such as SACCOS, GSL, MFIs	• Package the credit to fit all types of farmers • Tailor the credit to fit the seasonality needs
Credit product attribute ranking	*To identify the major determinants/ attributes of agricultural credit as perceived by the farmers*	Ranking 1. Interest rate 2. Loan conditions 3. Grace period 4. Accessibility of lending institution 5. Government recognition 6. Customer services 7. Experience of the institution	• Loan condition most important attribute • Horticultural farmers prefer 3 months' grace period while dairy farmers preferred a shorter period. • A small installment during grace period was acceptable.	• Speed of credit disbursement • Mobile transaction to reduce transaction costs • Competitive and reducing interest rate • Flexible repayments
Relative preference ranking by Financial institutions	*To understand how the attributes are met by financial institutions and the opportunities for a credit with environmental conditionalities*	Interest rate	Fairly rating from 9%-18% per annum	Competitive and reducing
		Grace period	No grace period	Flexible repayments terms
		Flexibility	Rated poorly and not flexible	Flexible repayments terms
		Terms & conditions	Mostly not conducive to farmers	Flexible repayments terms
		Speed of disbursement	Slow	Mobile transfers to reduce transaction cost
		Transparency	Hidden charges	Transparent and consistency
		Customer services	Fair	Farmer Advisors, Farm visit, calls and SMSs, Link to market

		Natural resources management	**NONE**	Link NRM condition to credit
		Technical training	Financial training during recruitment only	High quality technical training

The results of focus group discussions informed the designing of green credit model with three components;

i. Environmental conditional credit
ii. Agricultural technical assistance
iii. Natural Resource Management technologies and strategies

3.3 Environmental conditional credit

The credit system allows access to progressively higher levels of credit at progressively lower interest rates, conditional upon improvement of on-farm soil and water conservation measures which serve to improve soil fertility and watershed protection. The interest rate also incorporates the cost of agricultural technical advice.

3.4 Natural resources management strategies

Farmers are required to plant contour grass strips of approximately one meter width dependent on the slope and size of the farm. The system is designed such that farmers implement conservation measures incrementally over time. This ensures that farmers are not burdened with the construction of conservation measures but instead 'own' a constructive and incremental plan towards farm improvement. The grass strips form a physical barrier to soils moving downhill under gravity. Soils collect behind the grass strip, in time building up to form a flat terrace. Progressively, the grass strips are strengthened with agro-forestry trees. In addition to grass strips and agro-forestry trees, farmers are required to adopt and practice other climate smart agricultural practices including, contour farming, mulching, cover cropping, minimum/zero tillage, crop rotation, crop residues, fodder establishment and preservation precision farming, etc.

Table 2: Green credit schedule

Client Level	Loan Amount (Ksh)	Term (months)	Conservation Measure Required	Interest rate (%) pm
Starter	2,000	1	Attend a soil conservation introductory training	7
Bronze	4,000	2	Plant at least one grass strip on farm land	6
Silver	8,000	4	Plant grass strips on all of farm land as per conservation plan	5
Gold	16,000	8	Plant appropriate agro-forestry trees along grass strips at 20m interval	4
Platinum	64,000	12	Ensure grass strips and agro-forestry trees conservation measures are well-established and functioning	3
Platinum plus	150,000	18	Adopt other climate smart farming technologies.	2.5

3.5 Technical farming assistance

The advisory services provide after-sale extension assistance for the credit facility to help farmers build effective soil and water conservation measures, boost crop yields, and obtain better prices for their crops sold at market. Access to farming advice is also contingent on building soil and water conservation measures and reinforces the incentive delivered through the credit system. Additionally, the advisory service helps to build a strong relationship with clients, thereby reducing loan default risk. Technical farming advice is offered to a farmer twice a month, on-farm during monthly farm visits and in group meetings organized every month.

3.6 Sample size

The credit scheme was piloted with 100 farming clients in Sasumua sub-watershed in central Kenya. Farmers were purposively selected from existing farmer groups in the watershed as a nucleus for further expansion. A control group of 60 farmers was identified with similar geographical characteristics. For impact assessment, similar baseline farm and farmer socio-economic characteristic data was collected from both groups.

3.7 Data type and sources

Primary data was collected from participating farmers. All the participating farmers were trained on the aspects of the green credit scheme and were given the opportunity to borrow different credit amounts and simultaneously practice different levels of soil and water management practices as per schedule in table 2. For a farmer to access higher credit amounts, they were required to satisfy specified environmental conditions (Table 2). One hundred (100) farmers were interviewed from 5 different credit levels. Farm, farmer socio-economic and perception data was collected using a questionnaire administered through personal interviews.

Table 3: Distribution of farmers interviewed

Credit amount (Kshs)	No of farmers interviewed
Trained awaiting credit	25
2000	30
4000	11
8000	12
16000	15
64000	7
Total	100

3.8 Analytical methods

3.8.1 Contingent Valuation and Theory of welfare maximization

Contingent valuation is a survey-based method of eliciting how individuals evaluate goods and services not traded in the market place. These surveys only give meaningful results if they are properly grounded in a consumer utility maximization framework (Hanemann & Kanninen, 1998). According to welfare economics, rational individuals will accept any intervention whose outcome results in an improvement rather than deterioration of their welfare. It is generally assumed that consumers maximize their utility subject to a budget constraint and will, therefore, choose the option that gives them the highest utility. The individual acceptance of the intervention is reflected by their willingness to pay (WTP) or their willingness to accept (WTA). A high WTP/WTA is logically a proxy for its demand. Thus, the value placed on a good or service can be expressed as WTP/WTA to obtain it. A good or service associated with highest WTP/WTA would be the one that yields highest utility to that individual and vice ver-

sa. Subsequently, a high willingness to pay indicates high utility derived from the good or service and hence such would be given preference, implying its high demand.

In this context, WTP is the maximum amount of money a farmer would be willing and able to pay for the new product, which is a credit with environmental condition. Different people have different WTP for a particular good, and it is the distribution of this WTP among the target population that offers interesting market information. This distribution can be estimated through open-ended or close-ended questions. Open-ended questions provide direct estimates and are easy to analyze, but people often find it difficult to state their WTP for a new product (Hanemann & Kanninen, 1998). Close-ended questions are closer to real-life situations. In this method, WTP is not directly observed but assumptions about its distribution can be made, and its parameters, including the mean WTP of a population in monetary terms, can be estimated from survey data (Lusk *et al.*, 2004). Several approaches have been developed, including the single-bounded, the double-bounded, and the multi-bounded approaches.

In the single-bounded, dichotomous choice approach, the respondent is offered only one bid (a certain product at a certain price), to accept or reject. This method is incentive-compatible because it is in the respondent's strategic interest to accept, whether his/her WTP is greater or equal to the price asked, and to reject if otherwise (Mitchell & Carson, 1989). Utility maximization implies that a person will then only answer "yes" to the offered bid if his maximum WTP is greater or equal to the bid. However, the method requires a large sample size and is statistically not very efficient (Hanemann *et al*., 1991). In the double-bounded approach, a second bid is offered, higher or lower depending on the first response. This method incorporates more information about an individual's WTP and, therefore, provides more efficient estimates and tighter confidence intervals (Hanemann *et al*., 1991). The double-bounded approach has been used extensively in valuing nonmarket goods (Kaneko & Chern, 2003; McCluskey *et al.*, 2003: Kimenju & De Groote, 2008). The analysis, however, requires maximum likelihood estimation, and the interpretation is not always straightforward.

3.8.2 Double-bounded logit model

The double-bounded logit model was first proposed by Hanemann and Carson in 1985 and first implemented by Carson, Hanemann, and Mitchell in 1986. The questions asked in this

survey was to elicit discrete choice responses – “yes” or “no” hence a dichotomous choice format, which is also known as the referendum approach, or take-it-or-leave-it approach. The appropriate models for analyzing discrete response are the logit and the probit models. Both are non-linear and use the principle of maximum likelihood to estimate the parameters.

In this study, all respondents had borrowed a minimum baseline credit amount. Using this approach, all farmers had answered a “yes” to the first question of whether they were willing to borrow and pay credit with environmental condition. At a particular credit level, they were asked if they are willing to borrow a higher credit amount under the prevailing credit terms and conditions of soil and water conservation. If the respondent’s answer to this question was a “no”, a follow-up question was asked, whether the respondent was willing to take a lower amount. If the respondent's answer to the first question was a "yes," a follow-up question was asked whether the respondent was willing to take the next level credit amount.

In the double-bounded model there are four possible outcomes:

(a) the respondent is not willing nor able to borrow any environmental conditional credit (that is, "no" to both questions);
(b) the respondent is not willing to borrow any higher credit amount, but is willing to borrow a lower or same credit amount (that is, a "no" followed by a "yes");
(c) the respondent is willing to borrow higher credit amount from their current credit level, but is not willing to borrow to a certain credit limit (that is, a "yes" followed by a "no");
(d) the respondent is willing to borrow any credit amount offered (that is, "yes" to both questions).

These four possible outcomes can be denoted as NN, NY, YN and YY, where Y represents an affirmative answer and N a negative one. The model most applicable to examine the outcomes of such a survey is the standard double-bounded logit model (Hanemann *et al*., 1991). This is based on the assumption that the first and second responses are consistent. The second bid allows the researcher to place both an upper and a lower bound on the respondents true WTP when the outcome is either NY or YN. When the outcomes are either NN or YY, the second bid sharpens the single bound – it raises the lower bound or lowers the upper bound.

If we represent the applicable bid to the i^{th} respondent as B_i for the initial bid, B_i^d for the lower bid after an initial "no" response, and B_i^u for the upper bound after an initial "yes" response, then the relationships between the bids may be expressed as follows:

$B_i^u > B_i$ for YY and YN

$B_i^d < B_i$ for NY and NN

If we represent the likelihoods of the respective outcomes as π^{yy}, π^{yn}, π^{ny} and π^{nn} then the formulas for these likelihoods may be expressed as:

$\pi^{yy}(B_i, B_i^u) = \Pr\{ B_i \leq \max DD \text{ and } B_i^u \leq \max DD \}$

Information on a wider range of values, different amounts for the bids are assigned randomly between respondents *i*. The probability of receiving a "yes" answer to both questions equals the probability that the respondent's DD is higher than the highest bid offered:

$$\pi^{yy}(Bi, \mathrm{Bi}^{u}) = \Pr(Bi^{u,} < \mathrm{DDi}) = 1 - G(\mathrm{Bi}^{u})$$

Similarly, the probability of receiving a "yes" followed by a "no" equals the probability that the WTP of respondent *i* lies between the initial bid and the second, higher bid offered:

$$\pi^{yn}(Bi, \mathrm{Bi}^{u}) = \Pr(Bi < \mathrm{DDi}) < \mathrm{Bi}^{u} = G(\mathrm{Bi}^{u}) - G(\mathrm{Bi})$$

The probability of receiving a "no" followed by a "yes" is again the probability that *DDi* lies between the initial and the second, now lower, bid offered:

$$\pi^{ny}(Bi, \mathrm{Bi}^{u}) = \Pr(Bi^{u,} < \mathrm{DDi}) = 1 - G(\mathrm{Bi}^{u}) = G(\mathrm{Bi}) - G(\mathrm{Bi}^{d})$$

Finally, the probability of receiving two "no" answers is equal to the probability that *DDi* lies below the second, lowest bid offered:

$$\pi^{nn}(Bi, \mathrm{Bi}^{d}) = \Pr(Bi^{d,} < \mathrm{DDi}) = G(\mathrm{Bi}^{d})$$

where *G* (•) is some statistical distribution function with parameter vector *Zi*. It is the cumulative density function of the individual's true maximum DD. Logistic cumulative density function (cdf) will be applied in this case, represented as:

$$G(B) = [1 + e^{a - b(B)}]^{-1}$$

Combining the probabilities of the four outcomes, where B_i, B_i^u and B_i^d are the bids used for the i^{th} respondent, the log-likelihood function for a sample of *N* farmers takes the form:

$$\ln L^{D}(\theta) = \sum_{i=1}^{N} \left\{ di^{yy} \ln \pi^{yy}(Bi, Bi^{u}) + di^{nn} \ln \pi^{nn}(Bi, Bi^{d}) + di^{yn} \ln \pi^{yn}(Bi, Bi^{u}) + di^{ny} \ln \pi^{ny}(Bi, Bi^{d}) \right\}$$

where, d_i^{yy} , d_i^{nn} , d_i^{yn} *and* d_i^{ny} are binary- valued indicator variables with 1 denoting the occurrence of that particular outcome, and 0 otherwise.

The maximum likelihood estimator for the double-bounded model, $\hat{\theta}^{D}$ is the solution to the equation $: \partial \ln L^{D}(\hat{\theta}^{D}) / \partial \theta = 0$

The above model was used to estimate the predictive model for DD. The regressors are the bid values and the farmers' characteristics.

The DD function for green credit as incentive for soil and water conservation is specified as:

$DD_i = \alpha - \rho Bi + \lambda Zi + \varepsilon i$

Where B_i is the ultimate bid individual *i* faces, Z_i is a column vector of farmer, farm and credit characteristics and εi is a random term. The empirical representation of the green credit demand;

DD = *f* (credit amount, age, gender, education level, land size, income, collateral perception score, credit use perception score, interest rate perception score technical advice perception score)

The model was estimated using LIMDEP software. According to Hanemann *et al*., (1991); Hanemann & Kanninen (1998), the mean and median DD is given by α/ρ, obtained from the restricted model without farmers' characteristics, that is., by restricting $\lambda_i = 0$.

4.0 RESULTS AND DISCUSSION

4.1 Farm and farmer characteristics

Majority of the farmers in the experiment were men (65%). This is not surprising since most of the household heads and registered landowners are males. Their mean age is 50.4 years and the mean land size is 2.2 acres. The mean farmer's annual income is Ksh 208253.9 (Approximately USD 2082). On average, half of the mean land owned is allocated to crop and animal farming. Most farmers (60%) are not engaged in any other occupation apart from farming. Others engage in various income generating activities such as small-scale businesses (28%), crafting

(3%), formal employment (4%), and farm laborers (6%). Majority of the farmers have primary (40%) or secondary (44%) education while few of them (4%) didn't attend school while 3% and 9% have tertiary and university education, respectively.

Table 4. Farmer's perceptions

Perceptions	%Yes	% No
Land experiencing soil erosion	73.9	26.1
Practice any conservation method	60.4	39.6
Credit available in the area	66.7	33.3
Applied credit last year	25.2	74.8
Belong to an organized group	73.9	26.1
Received extension services in last one year	23.4	76.6

Most farmers (73.9%) understand that their farms experience soil erosion. About a quarter of the respondents (26.1%) have the opinion that their farms experience no soil erosion. This is mostly so for farmers whose farms are relatively flat where soil erosion is not easily noticed and those who have made some efforts to conserve their farms. A good number of farmers (60.4%) make attempts to practice soil conservation yet their farms experience soil erosion (Table 4).

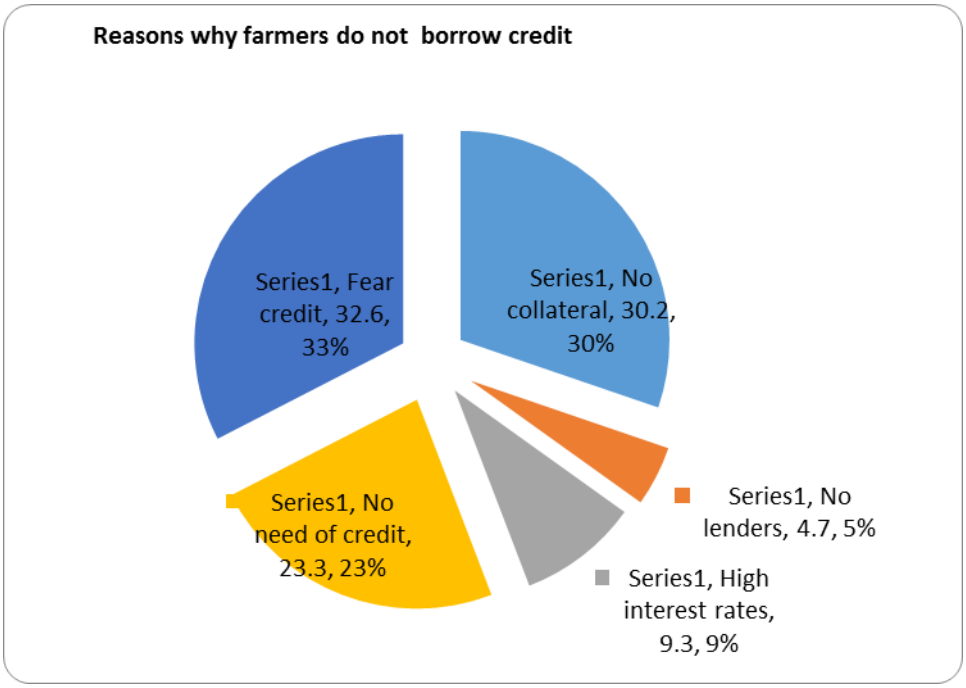
Grass strips (47%) are the most common method of conservation practiced by farmers in the area. This is due to the nature of slope of the farms in the area. Cut off drains are also common (19.7%) and these are constructed mostly around the farms to drain away excessive water especially during the rainy season. Other conservation methods practiced are grassed water ways, uncultivated fields and contours farming with 3% and 7.6% both respectively. The three main reasons that farmers gave for not conserving their farms are lack of information (60%) that their farm were experiencing erosion, lack of incentive to conserve (30%) and lack of conservation materials (10%).

Credit services are available in the area as pointed out by most farmers (66.7%) though only a quarter (25.2%) of them had obtained credit in the last one year. The main reasons why farm-

ers did not borrow credit despite its availability is fear of credit services (33%) and lack of collateral (30%). Other reasons were perception that they lack need for credit (23%), high interest rates (9%) and lack of accessible lenders (5%).

Most farmers (74%) in Sasumua area belong to organized groups which range from welfare group (55%), conservation and cooperatives (14%) each, agricultural group (11%) and bee keeping (8%). Farmers in most of these groups (over 50%) meet every month and majority (76.6%) of them had not received any technical training or extension services in the last one year.

Figure 2: Reasons why farmers do not borrow credit in Sasumua sub watershed



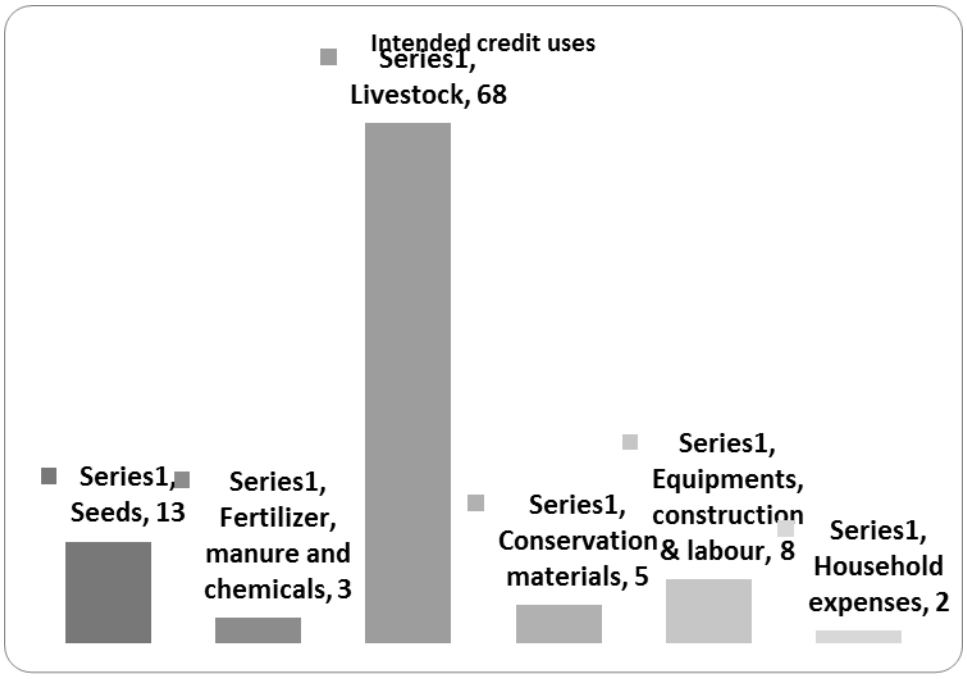
4.2 Econometric Results

4.2.1 Farmers mean demand for green credit

Following Hanemann *et al*. (1991), the mean WTP is given by α/ρ, obtained from the restricted model without farmers' characteristics. The restriction is placed on λ_i (coefficient for vector of farmers' characteristics to zero), where α and ρ are the coefficients for the constant and the bid respectively where the respective bid was the current credit amount the farmer had applied.

The farmers mean WTP (demand for green credit) is Ksh 90, 985 (USD 909). This is consistent and falls within the need assessment focused group discussion results in the same area that informed the modeling of the green credit within the range of Ksh 2,000 to Ksh 400,000.

Figure 3: Intended use of the green credit



Majority of the farmers intend to use the credit to purchase livestock (68%) mainly dairy cows. The main reason is that dairy enterprise in the area is more reliable, since the milk prices are relatively stable, has more and constant returns compared to crops enterprises. In addition, the dairy enterprise helps in fast accumulation of manure through utilization of grass strips conservation materials (mainly napier grass). This subsequently helps to improve farm yields and farm income, which farmers can use to repay the loan, helping improve their bankability.

4.2.2 Factors influencing farmers demand for Green credit

In determining the farmers mean WTP with consideration of their characteristics, the variable "perception on intended credit use" was eliminated due to multicollinearity effect with the intended credit use. The mean farmers' WTP for the green credit with considerations of their characteristics was Kshs. 115,194 (Table 5). This differs with the mean WTP without farmers' characteristics which was found to be Kshs.90, 985. The difference can be attributed to the fact

that most factors positively influence farmers WTP. This is an indication that with consideration of their characteristics, the farmers were willing to borrow a higher credit amount.

Table 5. Parameter estimates for Farmers' demand for green credit

Parameters	Coefficient	Std. Error	t	Sig.
(Constant)	115194.50	98490.88	1.22	0.23
Current credit amount (Initial Bid)	0.17	0.43	1.20	0.24
Farmer age	0.09	961.55	0.65	0.52
Client gender	-0.02	21850.55	-0.14	0.89
Education level	0.13	14048.55	1.03	0.31
Farm size	0.09	4351.27	0.68	0.50
Intended credit use	-0.15	6927.07	-1.13	0.26
Household annual income	0.05	0.06	0.34	0.73
Perception on collateral	-0.10	23409.06	-0.75	0.46
Perception on interest rate	0.06	19904.53	0.43	0.67
Perception on technical advice	-0.26	23169.90	-1.75	0.09

Farm and farmer characteristics: age, education level, farm size and household annual income positively influenced their demand for green credit, while gender and intended use of credit negatively influenced their demand. This is consistent with many studies involving household characteristics. Since most farm enterprises are male dominated, female dominated enterprises shy away from increased credit amounts. Farmers' perceptions on collateral and technical advice negatively influenced their demand for green credit. This was expected since the green credit scheme is designed to help farmers build credit history progressively such that they can access higher credit amounts without betting their land or any household property. In addition, technical advice is a strong component of the of the green credit scheme.

Contrary to expectations, perceptions on interest rate positively influenced their demand for green credit. This is not surprising since the green credit scheme is designed to dispel the fear of credit among smallholder farmers and the interest rate decreases with an increase in the credit amount and with improvement in on farm environmental conditions. The results show

that farmers are more concerned with the credit amount rather than interest rate. This portrays their dire need for credit.

5.0 CONCLUSION AND RECOMMENDATIONS

Small holder farmers in Kenya do not have access to credit services mainly due to fear of credit services. This emanates from the design and terms of credit services available. In addition, smallholder farmers lack collateral, which is a key requirement for credit access. Credit providers also perceive provision of credit to smallholder segment as risky. Those who provide credit to smallholder farmers segment do not consider investing in their soil, which is a basic capital on which their farming enterprise depends. This credit is designed to solve multiple elements which hinder credit access by smallholder farmers.

The study revealed that there is demand for green credit among small holder farmers in Kenya, farmers are willing and able to pay for environmental conditional credit since their mean annual income is higher than their mean demand for credit and most farmers need credit to invest in livestock. The credit scheme used in this study was designed for smallholder farmers. The green credit can be a good incentive for farmer's behavioral change towards natural resource management. A similar scheme can be designed for rangeland, forest and aquatic resources management.

This approach rests on the recognition that environmental degradation is frequently driven by economic activity. In turn, economic activity is underpinned by systems of credit which are blind to natural resource overuse. In order to achieve resource sustainability, credit terms need to be adjusted to ensure investment in natural resource management as well as simple repayment of outstanding debt. This type of scheme can contribute towards improvement to the farmer capital assets base (natural, financial, social, human and physical) which is basic for smallholder farmers' enterprises on which they depend for their wellbeing.

This methodology can be utilized to develop sustainable financial models for transitioning farmers to the adoption of improved agricultural practices that generate financial, social and environmental returns.

For a sustainable financial model and operationalization, the following policy interventions are proposed:

i. Provision of tax breaks for financial institutions providing loans which improve eco-system-based adaptation.
ii. Facilitation of creation of a fund for purposes of environmental lending.
iii. Prudential guidelines to require banks to incorporate environmental analysis into lending decisions.
iv. Initiation of discussions with central banks to assess scope for ecosystem-based credit.

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