PAYMENT FOR ENVIRONMENTAL SERVICES (PES) AND WILLINGNESS TO ADOPT IMPROVED FALLOWS: CASE STUDY OF CHIPATA DISTRICT

A report submitted to Department of Agricultural Economics and Extension Education of the University of Zambia.

By

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In partial fulfillment of the requirement for the Degree of Bachelors of Agricultural Extension

ACKNOWLEDGEMENTS

I'm highly indebted to my supervisor Dr E. Kuntashula for his relentless advisory role and encouragement rendered to me. Without his high-class professional contribution this research work would not have been realized. I wish to extend my gratitude to the entire staff of the Department of Agricultural Economics and Extension studies whose directives and constructive advice helped to improve on the quality of the work. Further, I would like to sincerely thank the project coordinator Mrs. M. Ngcobo in particular, for her consistent technical guidance on the expected quality research work.

I also acknowledge the input made by field staff, Mr. Kambole and Mr. Soko of Chipata district agricultural office, for data collection in the most honest way, without forgetting the enormous contribution made by fellow students to process the data. To my family, am so grateful for their support while pursuing my school work and for the inspiration towards my studies in general.

I dedicate this whole work to my wife Beauty who stood for me during the long periods of absence from home and her inspiration to work very hard and attain academic success.

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LIST OF ABBREVIATIONS

COS .....Compensation for Skipped Opportunities

CIS .....Co-investment in Ecosystem Stewardship

ES.....Ecosystem Services

EU .....European Union

PES .....Payment for Ecosystem Services

N .....Nitrogen

WTA .....Willingness to Accept

USA .....United States of America

USDA .....United States Department of Agriculture

ABSTRACT

PAYMENT FOR ENVIRONMMENTAL SERVICES AND THE WILLINGNESS TO ADOPT IMPROVED FALLOWS IN ZAMBIA: A CASE STUDY OF CHIPATA DISTRICT.

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The purpose of this research was to understand the farmers' willingness to adopt improved fallows if they were compensated. And the study area was Chipata district covering Chipata central and Chiparamba agricultural blocks. The factors which affect the willingness of small scale farmers to use improved fallows were determined by applying descriptive statistics, probit regression model, and the marginal effects. The result, as presented in descriptive statistical tables indicated high levels of farmers' willingness adopt improved fallows. Compensation would be necessary to promote implementation of such practice though found to be insignificant factor of the willingness at 0.05 alpha level in probit. Education, level of wealth and age, all, had a positive effect on conservation practice implementation and were found to be significant factors for willingness to adopt improved fallows. The estimated willingness to adopt improved fallows if compensated was significantly higher among those that have attended school than those who have not attended school. The trend was found to be no different where wealth is concerned, that is, higher among the wealthy than among the poor.

The study shows that there is need for government and other financing stakeholders to develop and strengthen institutional mechanisms that support farmers to participate in sustainable agricultural activities and secure food security along the way. This can be done through a well programmed extension services in order to enlighten farmers of their need to participate in environmental service provision through improved fallow technologies.

Since the majority of the farmers are willing to use improved fallows, the technology should form part of an integrated rural development programme and thereby meet more of the farmer's basic needs than it presently does. This can be enhanced through provision of economic incentives (compensation) to farmers using improved fallow should be considered.

Key Words: Compensation, Willingness to accept, Payment for Ecosystem Services, Improved fallows, Adoption, and Environmental Services

CHAPTER ONE

INTRODUCTION

1.1 Background

Payments for ecosystem services (PES), also known as payments for environmental services (or benefits), are incentives offered to farmers or landowners in exchange for managing their land to provide some sort of ecological service. They have been defined as "a transparent system for the additional provision of environmental services through conditional payments to voluntary providers." These programs promote the conservation of natural resources. (Tacconi, L. 2012)

Some PES programs involve contracts between consumers of ecosystem services and the suppliers of these services. However, the majority of the PES programs are funded by governments and involve intermediaries, such as non-government organizations. The party supplying the environmental services normally holds the property rights over an environmental good that provides a flow of benefits to the demanding party in return for compensation. In the case of private contracts, the beneficiaries of the ecosystem services are willing to pay a price that can be expected to be lower than their welfare gain due to the services. The providers of the ecosystem services can be expected to be willing to accept a payment that is greater than the cost of providing the services.

Strategies in place for promoting sustainable land use practices and their contributions to climate change include use of improved fallows in agriculture. Improved fallows are multi-purpose land use agroforestry practices that primarily improve soil fertility as well as provides ecosystem services. The technology fixes atmospheric nitrogen (N) into the soil and this N is subsequently made available to crops such as maize. The improved fallows also improve environmental quality through the generation of several ecosystem services, among others:

1. Carbon sequestration;
2. Improving the conservation of biodiversity through creation of a micro-climate and further improving soil quality;

3. Mitigation against deforestation since one of the major by-products of the technology is the provision of fuel wood (Kuntashula and Mafongoya, 2004); and
4. Improving the physical soil structure thereby increasing bulk density, porosity and aggregate stability thus decreasing soil erosion.

Among the common species of improved fallows used in Southern Africa include *Sesbania sesban, Tephrosia vogelii* and *Gliricidia sepium*.

The trade-offs between land uses that simultaneously provide environmental services and private farmer welfare have rarely been evaluated in Southern Africa. On a farm, land can either be diverted from agricultural practices into environmental service (ES) provision or land use can remain in agriculture but production activities are modified to encompass environmental objectives. In either case, the farmer's private welfare is affected, in most cases negatively, while society as a whole gains through the ES provision. It is therefore imperative to understand how a farmer would be willing to forgo some of his private benefits in exchange for the production of a public good that would not only benefit the farmer but society as a whole. Assessing this trade-off could partly provide some explanations on why adoption of agricultural technologies that provide environmental services such as the improved fallows has been sub-optimal in Southern Africa.

In an attempt to address the problem of adoption (low participation) in providing environmental services through improved fallows, elaborate theoretical research recommendations have been made.

For instance, Place F. *et al* (2005), observed that these services, or positive externalities[1] need to be rewarded by market mechanisms to socially optimal levels in order improve willingness to participate in the practice. This entails that where positive externalities exist, and there is no incentive system to reward individual farmers (investors) for the

[1] An externality occurs when the activities of one agent affect the activities of another either positively or negatively and when these activities are not taken into account by the first agent in making his or her decision (van Kooten 1993). In the context of agroforestry, for instance, improved fallows could provide external benefits through carbon sequestration and biodiversity to improve the quality of human life, all in the long-run. Benefits of environmental services associated with agroforestry are, to a large extent, external, to farmers' individual interests. Farmers may have little or no motivation to provide ecosystem services unless policy incentives are provided.

environmental services provided, then the level of investment (in this context, adoption of improved fallows by farmers) will be less than optimal (Ajayi *et al.* 2006).

Ajayi et al observe that farmers make decisions on alternative agricultural practices based on the incentives they perceive as individuals, without taking cognizance of the ecosystem benefits. And if conditional incentives mechanisms, are put in place, through which farmers are rewarded for the environmental services they provide, willingness to participate in providing these services would increase.

It has thus been suggested by that attaining a shift in the level of adoption of improved fallow technologies may require facilitation of public investment policies that recognize and reward investors for the environmental stewardship and benefits that are produced by improved fallows to society at large. It follows that knowing whether farmers are willing to make a trade-off between their private welfare and the provision of ES through uptake of improved fallows would provide a platform for determining the empirical appropriateness of this environmental stewardship reward. (Ajay *et al.* 2006)

Justification for the stewardship reward is that, farmers embracing improved fallows would leave part of their land fallow for 2–3 years. During this period they will not be getting any benefit from the improved fallow plots. However, the improved fallows will be supplying environmental services that are beneficial to the society as a whole. In the long run fallows will improve soil fertility hence adding to the farmers' private welfare through increased crop yields. The farmers' decision to take up improved fallows will therefore involve carefully weighing current costs and benefits against future costs and benefits. Such investments in soil conservation could thus be considered as a redistribution of resource use rates towards the future.

1.2 Problem statement

Whereas improved fallows are being promoted for improvement and/or upturn of soil fertility (Ajayi *et al.* 2006) and not necessarily for environmental service provision, it would be illogical to, casually, assume that farmers adopting the technology are willing to supply ES. The opposite would also be unreasonable, i.e. to assume that farmers who have not taken up improved fallows are unwilling to supply ES through the technology.

Yet still, much remains unknown concerning Zambian farmers' willingness to provide ES through improved fallows, particularly, how they would respond if they were paid for providing environmental services through improved fallow technology. The challenge in this regard is that of determining farmers' willingness (both users and non- users of improved fallows) to provide environmental services through the use of improved fallows that lowers their private welfare.

What factors would affect this willingness? And to what extent would farmers be willing to be paid to ensure provision of ES through improved fallows? The answers to these questions will help provide important insights on adoptability potential of improved fallow.

1.3 Objectives

1.3.1 General Objective

The main objective of this study is to assess how payment for environmental services (PES) affects the willingness to adopt improved fallows in Zambia.

1.3.2 Specific Objectives

1. Study the farming and demographic characteristics of small scale farmers who might be the potential recipients of payment for environmental services.
2. Identify factors that influence their willingness to implement the practices.

1.4 Hypothesis

1. PES/compensation can increase adoption of improved fallow technology

1.5 Rationale of study

Climate change is a global phenomenon that imposes economic, social, and ecological challenges to the global community and, to smallholder farmers particularly in low-income countries. Sustainable land use practices offer opportunities for smallholder farmers to adapt to climate change and related risks, but the challenge is that the adoption of such practices by farmers is low due to policy and institutional constraints, among other key reasons. Agroforestry-based land use practices (fertilizer tree/shrubs) could

provide opportunities for assisting smallholder farmers respond to the effects of climate change. Adoption of sustainable land-use practices could only be achieved when favorable deliberate policies along with their strategies are put in place.

Systematic and conditional reward mechanisms could help promote sustainable agricultural practices in combat of the negative effects of climate change and adaptation among farming communities. It is becoming clearer that climate change and food security are linked to each other and need not be addressed in isolation. In the low-income, food-deficit regions, like Zambia, responses to climate change should be viewed from the perspective of livelihood, especially food security considerations.

Since the majority of the Zambian farmers are small scale farmers who draw their livelihoods from agriculture, their practices have significant influence on the development of agriculture which is sustainable in the country. It common knowledge that agricultural expansion with poor land management practices and intensification pose a huge threat to sustainable farming activities. In view of this, payment and compensation for participation in sustaining land management practices such as improved fallow, could have a positive bearing on agricultural and human development in the country.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

According to The Millennium Ecosystem Assessment (2005) ecosystem services are the benefits, both tangible and intangible but mostly intangible, people obtain from ecosystems. Such benefits include those from provisioning services (the products obtained from ecosystems such as food, water and fibres), regulating services (the regulation of biophysical cycles such as climate), cultural services (non-material benefits such as aesthetics or spiritual values) and supporting services (services which allow for the provision of other services, such as nutrient cycles). Ecosystem services are often key factors in the production of economic value and hence material welfare. However, there is a well-established unwillingness to provide ecosystem services supposedly due to uncertainty and above all, lack of institutions that guide the supply and demand for ecosystem services (Balmford, *et al.* 2002).

The existence of market failure in the regulation and provision of ecosystem services means that the depletion of the environments that provide ecosystem services is often greater than socially optimal, and similarly, the production of ecosystem services by economic agents is less than socially optimal (Ferraro and Kiss, 2002). Ecosystem services are often, although not exclusively, public goods, and their benefits may materialize at different scales, from local (for instance, pollination of crops) to global (carbon bio-sequestration). Particularly on larger scales, considerable externalities, a lack of well-defined property rights and limited information hamper efforts to optimize ecosystem service provision and protection between those who benefit from an ecosystem service, and those who affect its provision (Engel, *et al.* 2008; Ferraro and Kiss, 2002). Payments for ecosystem services (PES) programs are one potential solution to this problem, which work by using material incentives to encourage environmentally beneficial land management actions by individuals or communities. PES programs seek to alleviate environmental externalities, strengthen property rights and improve information flow regarding the desired levels of ecosystem services. In doing so, PES

programs internalize the benefits associated with enhancing or maintaining ecosystem services to ensure land managers (or other providers of ecosystem services) face incentives concordant with the interests of ecosystem service users (van Noordwijk and Leimona, 2010).

Although established programs are still rare in developing countries like Zambia, increasing attention is being paid to how they might be used in such contexts and what kind of design attributes are required for their success (Engel, *et al.* 2008;). For PES to be widely successful there is a strong need to adapt PES principles to varied circumstances (Jack, *et al.* 2008; Swallow *et al.* 2009).

An important part of adapting policy to a particular circumstance is taking into account the preferences of those likely affected by the policy's imposition. This research will use choice experiment concept that quantifies ES providers' preferences for key design attributes of PES, in Eastern province, Chipata district. Eastern province is among the prominent places in Zambia thriving with agricultural activities. But to the extent that agricultural activities are well established, the expansion taking place represents considerable threat from deforestation which is an environmental hazard (Brooks, *et al.* 2002) PES may be a suitable policy instrument to alleviate this threat, and although there are not currently such market-based programs in place in Zambia. This research looks at farmer preferences for key elements of PES program design, including payment type, payment amount and conditionality levels. Willingness to accept (WTA) values for a variety of hypothetical PES programs are presented. In quantifying farmer preferences this research looks at what kind of responses can be expected from farmers under different PES designs.

Where selection of design elements for the choice experiment is concerned, this research makes reference to two paradigms recently proposed by van Noordwijk and Leimona (2010): "compensation for opportunities skipped" (COS), where payment is given for avoided actions which would otherwise be environmentally detrimental, and "co-investment in ecosystem stewardship" (CIS), where the beneficiary makes an investment in the land management actions of the ecosystem provider that have environmental

benefits. This research will particularly emphasize on CIS, tailor it to the local context and incorporate them into the set of choice experiment attributes and options.

2.1 Characteristics of Payment for Ecosystem Services

The term "payment for ecosystem services" receives broad application to a range of market-based environmental policies (Engel *et al.* 2008). However, a stricter definition provided by Wunder, (2005) is generally used in recent documentation of PES. Wunder (2005) defines PES by five characteristics:

1. *It is voluntary:* PES is distinguished from command and control policies by being a negotiated framework between a purchaser and a provider of an ecosystem service. This assumes that providers have real land-use choice.

2. *It is based on a well-defined environmental service:* The purchaser must be confident they receive the agreed quantity of the relevant ecosystem service, either through direct measure or through an appropriate proxy. A PES program for a service that is difficult to monitor is unlikely to hold the confidence of purchasers. Given the diffuse, indirect nature of many ecosystem services this can be a serious impediment.

3. PES *involves payment from at least one purchaser,* and

4. *To at least one provider:* A PES differs from other conservation and development policy instruments in that it is a commercial arrangement where both parties benefit from the transaction. Payment and monitoring of service provision often take place through an intermediary such as a government acting on behalf of taxpayers or businesses.

5. A working PES program is contingent upon the ongoing provision of the ecosystem service in question, and hence payments are *conditional:* they are linked to provision with monitoring to ensure the contract is being upheld.

2.2 Motives for providing incentives in production of ecosystem services

Though the goal of all PES programs is the procurement of some sort of ecosystem service, the reasons why organizations or governments would incentivize the production of these services are diverse. For example, the world's largest and longest running PES program is the United States' Conservation Reserve Program, which pays about $1.8 billion a year under 766,000 contracts with farmers and landowners to "rent" a total 34,700,000 acres (140,000 km^2) of what it considers "environmentally-sensitive land." These farmers agree to plant long-term, resource-conserving covers to improve water quality, control soil erosion and enhance habitats for waterfowl and wildlife. (USDA, 2012)

In 1999, the Chinese central government announced an even more expensive project under its $43 billion Grain for Green program, by which it offers farmers grain in exchange for not clearing forested slopes for farming, thereby reducing erosion and saving the streams and rivers below from the associated deluge of sedimentation.[8] Notably, some sources cite the cost of the entire program at $95 billion. Many less extensive nationally funded PES projects which bear resemblances to the American and Chinese land set-aside programs exist around the world, including programs in Canada, the EU, Japan and Switzerland.

2.3 Challenges to providing environmental services through improved fallow.

There are, however, a number of technical challenges to the introduction and expansion of agroforestry. Many are associated with misperceptions concerning the interactions between trees and crops, and most can be solved through demonstration and training. Many of the obstacles to wider use of agroforestry are related to policies. Agricultural policies often entirely ignore trees on farms, so agricultural authorities do not develop incentives for tree cultivation or include agroforestry in extension and other guidance. For example, until recently farmers in the European Union were not eligible for Common Agricultural Policy subsidies for cereals if they grew their grains in association with trees, and more recent policy that is favorable to agroforestry has been weakly implemented to date. And in the USA, agroforestry has not been well recognized,

although a June 2011 announcement of an Agroforestry Plan by the U.S. Department of Agriculture expects to strategically use programs such as farm and conservation assistance, forest landowner assistance, extension, education and outreach, and many other services to promote agroforestry. (Rigueiro-Rodríguez *et al.* 2009)

Another major challenge, in particular for resource-poor farmers in developing countries is that trees are perennial crops that are comparatively slow to grow. This means that farmers need to invest scarce resources in tree establishment and management, and do not begin to see benefits for a number of years. Policies are needed to provide incentives for investment in advance of benefit.

Thus, there is little incentive as yet for farmers to generate the many societal environmental services that are possible through agroforestry. Trees on farms are often governed by over-reaching forestry legislation that treats all trees as though they are in forests, and punishes farmers for managing trees on their land. (Garrity *et al.* 2009)

2.4 Conceptual Framework

It is assumed that farmers face a loss of utility due to the conditionalities of a PES contract, and a gain of utility from the associated payment. A farmer is assumed to choose a contract if the net utility from that choice is greater than either no choice or any competing choices. Based on random utility theory, the probability of a farmer making a particular choice is assumed to increase as the utility of that choice increases (Ben-Akiva and Lerman, 1985).

Casey (2004) came up with a model of adoption in which they theorize that whether or not the farmer invests in agroforestry has to do with whether or not the farmer perceives the benefits of the system to outweigh the costs associated with implementing the system and how confident the farmer is in his own prediction of the potential costs and benefits. This decision is firmly rooted in the economic concept of utility maximization (Ellis, 1988). The farmer is trying to maximize utility, which is a function of both expected income and other things, expressed as follows:

Farmer: Max U (EI, x)

This means that if utility function is weakly separable, we look specifically at the expected income associated with agroforestry. The farmer can choose to invest in agroforestry or not. The farmer will invest in agroforestry if he expects his income to be greater with agroforestry than without.

Invest in Agroforestry if: EI (AF) > EI (no AF)

Some researchers have for found that NPVs associated with agroforestry are higher than NPVs for monocultures and other forms of traditional agriculture (Sullivan, 1992), yet adoption/investment rates are low. This is where the "uncertainty" argument comes into play. In their conclusion, Casey observed that all the evidence in the world can be presented to farmers about the benefits of agroforestry, but if the farmer has very little "relevant" information of his own, he will place very little "weight" on the evidence presented. Therefore, investing in agroforestry is now a function of the profit forecast (information presented by the agroforestry practitioner) and the "weight" the farmer places on this information.

Investment in AF = f (profit forecast, weight)

This implies that investment in agroforestry is a function of profit forecast and the weight participants place on the activity.

Perhaps more important are the specific ways in which farmers have invested in their own human capital and which of these is related to interest in participating in an agroforestry development program.

CHAPTER THREE

RESEARCH METHODS AND PROCEDURES

3.1 Area of Study

The study will be conducted in Chipata district which is the provincial capital Eastern province of Zambia. Chipata district has been chosen because of the large number of smallholder farmers and a reasonable number of large scale mechanized farmers. Each year, in this region, vast areas of land are cultivated for crop production. The main crops of interest have been maize, groundnuts, cotton and tobacco all of which are mostly grown using monoculture system. This exposes the environment to potential eventual degradation as evidenced by increasing levels of nutrient fertilizers need for each cropping season.

There are alternative cropping systems recently proposed that could maintain some degree of ecosystem functionality while allowing for ongoing crop production. Although inferior to original forest, maintaining agro-forests would be preferable to complete forest cover loss.

3.2 Sampling Procedures

Random sampling was be done from two groups of farmers, i.e. those that are using improved fallow technology and those that have not yet adopted. A sample of 100 households was be randomly selected from the area; sampling was done using the lottery method in which 50 farmers were picked by researcher from a list of farmers registered by block officer in farmer registers from each of the two agricultural blocks. The number selected in each of the two blocks was determined by the number of smallholder farmers willing to take part. This study used a choice experiment to quantify preferences for different elements of PES program design.

3.3 Research Design

In this research the probit model was be used, with adoption of improved fallows as the dependent variable and level of PES/compensation as the main independent variable.

$$y_i = \begin{cases} y_i^* & if\ y_i^* > 0 \\ 0 & otherwise \end{cases}$$

where

$$y_i^* = \beta X + \mu_i \qquad \mu_i \neg N(0, \hat{\sigma}^2)$$

Independent variables to be studied are:

X_i were = compensation, education, physical assets (wealth), age, and sex.

3.4 Data Analysis Tools

The field data collected was analyzed in STATA to produce descriptive statistics and the output was organized using Probit and the marginal effects were run .Heteroscedasticity may be present across households due to the use of cross sectional data. The probit model was be used to estimate the probabilities.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Compensation and willingness to use improved fallows.

Table 1: Compensation levels

Compensation	Frequency	Percentage
Less than K500	43	43%
More than K500 but less than K1000	34	34%
More than K1000 but less than K5000	16	16%
K5000 or more	7	7%
Total	100	100.0%

Source: Own survey data (2015)

This research found that the majority of the farmers were willing to adopt improved fallows and thus provide environmental services, if compensated. As shown in Table 1 above, this research found that 77% of the farmers are willing to adopt the use of improved fallows if they were compensated with K1000 or less. 16% of the farmers were only willing to adopt improved fallows if the compensation was raised to between K1000 and K5000.

Table 2: Farmers willingness to adopt the use of improved fallows

Willingness	Frequency	Percentage	Cumulative
No	25	25	25
Yes	75	75	100
Total	100	100	

Source: Own survey data (2015)

This research shows that the majority of the farmers interviewed were willing to use improved fallows. As shown in Table 2 above 75% of those interviewed are potential adopters and/or users of improved fallows.

4.2 Demographic characteristics of the sample of study.

Table 3: Age of House Hold Head

Age	Frequency	Percentage	Cumulative
25-35	25	25.3	25.3
36-45	36	36.4	61.6
46-55	23	23.2	84.8
56-65	2	2.0	86.9
66-75	6	6.1	92.9
76 and above	8	8.1	100.0
Total	100	100.0	

Source: Own survey data (2015)

The results of this research showed, as indicated in Table 3, that the majority of the household heads were of age between 25 and 55 years, polling a cumulative percentage of 84.8. And only 8.1% were age 76 and above.

Table 4: Sex of House Hold Head

Characteristics	Frequency	Percentage	Cumulative
Female	8	8	8
Male	92	92	100
Total	100	100	

Source: Own survey data (2015)

As presented in Table 4 above, the sample was found to constitute more of male household heads. Since most decisions in most rural communities are made by household heads, the composition of more male headed households may encourage adoption of the improved fallows.

Table 5: Marital Status of the House Hold Head

Status	Frequency	Percentage	Cumulative
Married	83	83.0	83.0
Single	1	1.0	84.0
Widow/widower	7	7.0	91.0
Bachelor	2	2.0	93.0
Divorced	2	2.0	96.0
Non response	5	5.0	100.0
Total	100	100.0	

Source: Own survey data (2015)

It was also found, as indicated in the Table 5 above that the majority of the participants were married. This could meant that the research was conducted on individuals who were responsible enough and mature to make informed decisions and views openly.

Table 6: Educational Level of House Hold Head

Level of Education	Frequency	Percentage	Cumulative
Never been to school	23	23.0	23.0
Attended primary	16	16.0	39.0
Completed primary	15	15.0	54.0
Attended secondary	20	20.0	74.0
Completed secondary	21	21.0	95.0
Attended tertiary	3	3.0	98.0
Completed tertiary	2	2.0	100.0
Total	100	100.0	

Source: Own survey data (2015)

This research also found that a percentage of 23 of the respondents did not attend school. Table 6 above, shows that 76% of household heads had attained some education at different levels, leaving a percentage of 23 as those who never attended formal education. Additional, only 5% of the household heads attended tertiary education.

Table 7: House Holds Belonging to farming related groups.

Response	Frequency	Percentage	Cumulative
Yes	66	66.0	66.7
No	10	10.0	75.8
Non response	24	24.0	100.0
Total	100	100.0	

Source: Own survey data (2015)

In this community, an upward of 75% of the respondents did not belong to any farming related groups as shown in Table 7 above. This means that the majority of farmers prefer to carry out farming activities without belonging to organized farming groups and this can have an effect on their knowledge levels about new agricultural innovations. This is so because as farmers associate in these groups they tend to share experiences and influence each other in decision about new innovations.

Table 8: House Hold Head receiving income from livelihood strategies

Livelihood Strategies	Number of Counts	Percentage
Petty trading	23	6.3
Gardening activities/off season farming.	31	8.5
Local chicken rearing	32	8.7
Goat rearing	35	9.6
Cattle rearing	49	13.4
Remittances	10	2.7
Sale of rain fed food crops (maize)	61	16.7
Sale of rain fed cash crops (cotton)	92	25.1
Piece work	20	5.5
Sale of charcoal	2	5
Others (bricklaying/transport)	11	3.0
Total	366	100.0

Source: Own survey data (2015)

This research found that there is a wide range of livelihood strategies as outlined in the Table 8 above. As indicated in the table, cattle rearing and sales rain-fed maize and cotton with each polling a percentage of 13.4, 16.7 and 25.1, respectively. This indicates that about 50% of households in this community have some descent level of income arising from the aforementioned.

4.3 Factors Affecting Willingness to Adopt Improved Fallows if Compensated

This research has shown, as presented in Table 9 below, that the significant factors affecting willingness to adopt improved fallows, if compensated included; wealth, which in this case was measured by possession of bicycle, iron roofed house and cattle rearing. Attending level of education was also found to be a factor looking at the influence of those who have gone as far as completing secondary school education. Age was also found to a factor.

Table 9: Probit regression results

Probit regression		Number of obs	=	100
		LR chi2(10)	=	34.13
		Prob > chi2	=	0.0002
Log likelihood = -39.16739		Pseudo R2	=	0.3035

willingness	Coef.	Std. Err.	z	p > | z |
compensation	.5188322	.7905815	0.66	0.512
bicycles	.6834385	.4344108	**1.57**	0.116
iron_roofed_house	.6840876	.6015393	1.14	0.255
cattle_rearing	.0094706*	.0048748*	**1.94**	0.052
sex	.0063677	.6007873	0.01	0.992
advise	.2488601	.5946768	0.42	0.676
attend primary	1.215252**	.5711447	**2.13**	0.033
complete primary	1.347838**	.5841745	**2.31**	0.021
complete secondary	1.262705**	.571512	**2.21**	0.027
age	1.538454**	.662655	**2.32**	0.020
constant	-2.974806**	1.204364	-2.47	0.014

Significance: *** p<0.01, ** p<0.05, * p<0.1 Source: Own survey data.

The statistical result presented above was based on five main variables and these are: *compensation*, *education*, *physical assets* (*wealth*), *soil conditions*, *age* and *belonging to farmer group*. They are presented as follows: compensation, age, sex, education (attndprim, compprim, attsec, and compsec), and wealth (cattle rearing, biycles, and iron_roofed_house).

Results from this research, as tested in probit above, shows that though compensation is not signification at 95% level of confidence, it has a positive effect on willingness as indicated by the positive value of z (0.66). As shown in Table 1, if farmers were compensated K1000 or less the majority of them (77%) will be willing to use improved fallows.

The results, as presented in Table 9, shows that education has a positive effect on farmers' willingness to use improved fallows. The results show that at 0.05 level of alpha regression coefficients for attending primary and completing secondary education (i.e. attndprim, compprim and compsec) were found to be statistically different from zero, with z-values of 2.13, 2.31 and 2.21 respectively. This means that attended and completed secondary school, they are likely to be willing to use improved fallows. This is

so because when people acquire more education they begin to experience and understand environmental issues more fully and are willing to participate in an activity that could sustain their future livelihood. The strength of those who have attended school is in their power to reason and respond quickly.

Being wealthy, as measured by possession of such assets as bicycles and cattle rearing, was also found to be significant at 95% level of confidence. Looking at cattle rearing; it was found to be significance at alpha level of 0.05, meaning that the more people improve wealth the more likely that they will respond improved fallow technology possibly because they have enough land which they can spare for other activities.

Age has also been found to be statistically different from zero at 0.05 level of alpha with a z-value of 2.32. The positive z-value means that as people grow older, they are more likely to be willing to use improved fallows. This is because, as people grow older, they have gone through many experiences and their level of conception on environmental issues increases. This makes them to appreciate programs meant improve their livelihood.

Table 10: Marginal effects

Marginal effects after probit
y = Pr(willingness) (predict)
= .83228129

Variable	dy/dx	Std. Err.	z	p > | z |
compensation	.1016267	.11756	0.86	0.387
biycles	.1987718	.13789	1.44	0.149
iron_roofed_house	.2129695	.21273	1.00	0.317
cattle_rearing	.0023759	.21273	**2.12**	0.034
sex	.0015933	.14994	0.01	0.992
advise	0678897	17404	0.39	0.676
attend primary	.1973861	.0625	**3.16**	0.002
complete primary	.2058381	.06024	**3.42**	0.001
complete secondary	.2176188	.06853	**3.18**	0.001
age	.5357484	.23088	**2.32**	0.020

Source: Own survey data (2015)

As presented in Table 8 above, holding all other variables at their means, a unit change in cattle rearing increases probability for willingness by 0.0023759, that is, 0.2%. This

means that even if cattle rearing appears to be significant at 0.05 alpha level, the likelihood of a unit change in ownership of cattle is almost nonexistent.

Where education is concerned, there are probabilities of 19.5%, 20.6% and 21.8% for attending primary education, completing primary education and completing secondary education, respectively, to bear an influence willingness to use improved fallows.

The highest probability was found to be that of age. And as shown in Table 8, a unit change in age increases the probability for willingness by 53.6%. This shows that age is the most significant factor affecting willingness to use improved fallows.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

This research has shown that compensation though not significant at 95% confidence interval, it has a positive effect on willingness to adopt improved fallows. This means that Payment for Environmental Services (PES) schemes, (in which the provider of environmental service is the farmer) can promote more sustainable resource management such as the use of improved fallows. This is in line with predictions of environmental economists who have time and again advocated the idea that if farmers are compensated for providing environmental services, improved fallows utilization as an alternative to use of conventional soil fertility substances, would increase. It has been shown in this research that education and age are significant factors influencing willingness to use improved fallows. It has also been shown that the more wealth people accumulate through asset possession, the more likely they are to participate in providing environmental services.

5.2 Recommendations

There is need for government and other financing stakeholders to develop and strengthen institutional mechanisms that support farmers to participate in sustainable agricultural activities and secure food security along the way. So that as they provide environmental services, their material food needs are also being met. This could be done through a well programmed extension services in order to enlighten farmers of their need to participate in environmental service provision through improved fallow technologies.

This study examined the willingness to provide ecosystem services and compensation as a case study in Chipata. The willingness to provide ecosystem services in the study area is fundamentally due to exposure and awareness to improved fallows technology. Since the majority of the farmers are willing to use improved fallows, they should be encouraged by the government to do so. There is a need to improve both formal and informal improved fallow education among the rural communities for it to become more widely accepted by local populations.

To effectively improve rural living standards, improved fallow technology should form part of an integrated rural development programme and thereby meet more of the farmer's basic needs than it presently does. Technical assistance is needed to facilitate the spread of practices through sound extension services. More so, adequate information is required to keep farmers abreast of current trends and development in the practices of improved fallows. Provision of economic incentives (compensation) to farmers using improved fallow should be considered. It is also worth mentioning that more research needs to be carried out to find out how the wealthy and those with higher level of education, can be encouraged to participate in the use of improved fallows.

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APPENDICES

Appendix 1: Questionnaire

QUESTIONNAIRE PREPARED FOR PES AND THE WILLINGNESS TO ADOPT IMPROVED FALLOWS IN ZAMBIA IN CHIPATA DISTRICT

Payment for Environmental Service to Enhance Land Productivity and Farmer Participation in Managing and Maintaining Sustainable Agriculture.

Name of Enumerator
.....

Date of
Interview.....

Section A: Household basic characteristics

1. District	
2. Agricultural Block	
3. Camp	
4. Village	
5. Name of household head	
6. Status of respondent in household	*1= head of HH, 2 = Spouse, 3 = child, 4= worker, 5= other relative*
7. Sex of household head	*1= Male, 2= Female*
8. Educational level of head of HH	*1= Never been to school, 2 = Attended primary, 3= Completed primary, 4 = Attended secondary, 5 = Completed secondary, 6 = Attended tertiary, 7 = Completed tertiary*
9. Age of head of HH (years)	
10. Marital status of head of HH	*1 = Married, 2= Single, 3 = Widow(er), 4 = Bachelor, 5 = Spinster, 6 = Divorced*

Household Composition

	Under 9		Children (9 - 15)		Adults (16 - 49)		Elderly (49+)	
	M	F	M	F	M	F	M	F
11. No. of people living in homestead								
12. No. of chronically ill								

"Living" is defined as someone who stays there at least for three months in a year & chronically ill is defined as, sick and unable to work for a total of 3 months over the last 12 months

Section B: Wealthy status and use of improved fallows

13. Is the household using improved fallows (IFs)? *1= Yes, 2 = No (If No, skip next question)*

14. When did the household start using improved fallows? _____

Does household possess any of the following physical assets? (tick all that apply)	**Quantity Owned (Now)**
16. ☐Cattle	
17. ☐Oxen	
18. ☐Goats	
19. ☐Poultry	
20. ☐Pigs	
21. ☐Donkeys	
22. ☐Ox carts	
23. ☐Ox drawn ploughs	
24. ☐Ox drawn harrows	
25. ☐Cultivators	
26. ☐Ridging plough	
27. ☐Knapsack sprayers	
28. ☐Bicycles	
29. ☐Radios	
30. ☐TV set	
31. ☐Iron roofed house	

32. Does the household or any member of the household belong to any farming related group?
1= Yes 2= No (if No. skip next two Questions)

33. When did the household join the organization cited above?
_____

Does household receive income from the following livelihood strategies? (tick all that apply)	**Approximate how much per year (ZK)** – use the last 12 months period
34. ☐ Petty trading (Specify)	
35. ☐ Gardening activities/Off season farming	
36. ☐ Local chicken rearing	
37. ☐ Goat rearing	
38. ☐ Cattle rearing	
39. ☐ Remittances	
40. ☐ Sale of rain fed food crops (specify crops)	
41. ☐ Sale of rain fed cash crops (specify crops)	

42. ☐ Piece work	
43. ☐ Sale of charcoal	
44. ☐ Other (Specify)	

Section C: Agricultural practices

45. What are the three major agricultural related challenges that the household faces *(list them in order of severity, with most severe ranked as 1)*:

_____

_____

46. What are the predominant type of soils exists on your farm?

1= Sandy, 2 = loamy, 3 = Clay, 4 = Sand loamy, 5 = other (specify) _____

47. How much land do you own? _____(*owned = exclusive long-term access*)

48. How much land is usually uncultivated on your farm? _____

49. Fill in the below Table to indicate the main crops

Crop planted	Total area cultivated (*limas*)	Harvested (bags)	Value of harvest (ZMK)
Local Maize			
Hybrid maize			
Sorghum			
Groundnuts			
Cotton			
Sunflower			
Other (specify)			

51. Please indicate the tree species grown on your land.

Trees	**1=Yes, 2=No**	**Area**
Sesbania sesban		
Gliricidia sepium		
Cajanus cajan		
Tephrosia		
Faidherbia albida (musangu tree)		
Other tree (specify)		

Section D: Improved fallows and environmental impacts

52. May you list the environmental impacts of improved fallows in order of importance (in your assessment)

    _____

    _____

53. Do you experience soil erosion on your farm? *1 = Yes 2 = No*

54. To what extent do you agree with the following statement 'improved fallows prevent soil erosion'

    1 = strongly agree 2 = Agree 3 = Disagree 4 = strongly disagree

Section E: Valuation of environmental services provided by improved fallows

Interviewer: By planting improved fallows on your farm, you are supplying services that directly benefit you and the farm (for example reducing on-farm soil erosion and making the soil easier to work with) and at the same time providing benefits to many other people who are situated far away from the farm (for example, by planting improved fallows instead of using inorganic fertilizers, you avoid polluting ground water and by so doing, many people benefit).

1. *Are you aware that by planting improved fallows, you benefit very many people situated far away from your farms?* Yes/No

(If farmer is not aware, explain to farmer these services until farmer understands)
Interviewer: Since you have to wait for 2 – 3 years before you start seeing the soil fertility improvement benefits of the improved fallows, your crop output decreases in the intervening period.

2. *According to your own understanding on the performance of improved fallows, is the above assessment true?* Yes/No

Interviewer: However you may also be aware that your output would not have decreased had you not used improved fallows.

3. *Do you agree*? Yes/No

(If farmer does not understand 2 & 3 explain concept of opportunity cost for crop forgone during the time land is fallow)

4. Have you ever been advised in the use of improved fallow?

   1=Yes; 2=No
   By whom?
   A) Agroforestry research agent

   B) Farmer friends who have been using improved fallows.

   C) Others, please mention? _____

Interviewer: Government is considering setting up a scheme to compensate farmers who would provide environmental services through improved fallows so that farmers who engage in improved fallows should not be at a loss especially during the first two years of the practice.

5. *Do you understand what I said above? Do you have any clarifications you require?*

Interviewer: The practice of improved fallows on your farm will benefit many people beyond the farm. For instance soil erosion on your farm will reduce, which means that when it rains the water in the rivers will have reduced levels of mud.

6. *Do you understand this or you need further clarifications?*

Interviewer: The extent of soil erosion on your farm will depend on how much land is left without improved fallows. For example, if you remove all the trees on the farm like many farmers do, the crop output would increase but the level of soil erosion will increase also thereby affecting other people beyond this farm.

7. *Does this assessment make sense to you or I should explain further?* Yes/No

Interviewer: I would now like to ask you questions about this compensation (fund). As I told you earlier, government is considering implementing payment for ecosystem services (PES) to compensate for using improved fallows.

8. *If you were compensated for provision of ES, would you be willing to participate in using improved fallows?* Yes/No

If YES, continue with Q9, if NO, please explain why you would not be willing?

_____

_____

9. How much would you expect government to pay per *Lima* per year in compensation for using **improved fallows** on land where you grow the following crops and/or reserved for grazing animals? Give a reason for each compensation level.

Name of crop/grazing land	**Compensation (ZMK)**	**Reason/explanation**
Maize		
Sorghum		
Tobacco		
Millet		
Cotton		
Sunflower		
Other		

THE END
THANK YOU SO MUCH FOR COOPERATING