SOCIO-ECONOMIC FACTORS INFLUENCING UPTAKE OF COFFEE PRODUCTION RECOMMENDED PRACTICES IN KICHWAMBA AND KIRUGU SUB-COUNTIES RUBIRIZI DISTRICT

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DECLARATION

I, **Ahimbisibwe Jerome Ronalds,** do here by declare to the Senate of Bishop Stuart University, that this dissertation is my original work and has neither been submitted nor being concurrently submitted for a master degree award in any other institution. I further affirm that this report has neither in whole nor in part been previously presented elsewhere for any academic award.

Signature..................................... Date 28/12/2022

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APPROVAL

This dissertation entitled "**Socio-economic Factors Influencing Uptake of Coffee Production Recommended Practices in Kichwamba and Kirugu Sub-counties Rubirizi district**" has been done under my supervision and is now ready for submission with my approval.

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DEDICATION

I dedicate this dissertation first to the al mighty God who makes all things possible and to my ever loving parents and the entire family.

ACKNOWLEDGEMENT

Above all, I wish to thank the Almighty God whose grace and mercy guided me throughout this study.

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LIST OF ABBREVIATIONS

ACP	Africa, Caribbean and Pacific
AFS	Agro forestry Systems
AOR	Adjusted Odd Ratios
BMER	Bale Mountain Eco region
CF	Conceptual Framework
CI	Confidence Interval
CMG	Collaborative Marketing Groups
FFS	Farmer Field Schools
GDP	Gross Domestic Product
IITA	International Institution of Tropical Agriculture
IPM	Integrated Pest Management
K2O	Potassium Oxide
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries MDGs Millennium Development Goals
NARO	National Agricultural Research Organization
NDP	National Development Plan
NUCAFE	National Union of Coffee Agribusiness and Farm Enterprises
OVF	Organic Vegetative Farming
PEAP	Poverty Eradication Action Plan
PMA	Plan for Modernization of Agriculture
P2O5	Phosphorus Pentoxide

SSA	Sub-Saharan Africa
SPSS	Statistical Package for Social Scientists
UCDA	Uganda Coffee Development Authority

ABSTRACT

The study was on socio-economic factors influencing uptake of coffee production recommended practices in Kichwamba and Kirugu Sub-counties Rubirizi district and was conducted in February 2021. Objectives were; to identify the coffee production systems and practices used, identify the socio-economic challenges associated with uptake of recommended practices for coffee production and to identify the policy interventions to address the challenges associated with use of recommended coffee practices. Farmers continue to register low coffee yields hence affecting their livelihoods and incomes and to achieve maximum coffee production requires that farmers apply recommended practices since quantity and quality of the crop relies on practices used. A cross-sectional survey was conducted using simple random sampling and a total of 376 coffee farmers were sampled. Results indicated that *Arabica* coffee commonly grown variety (54.0%), two major systems ie intercropping and mono-cropping. The coffee recommended practices used were; weeds control (23.7%), shading (21.5%), pruning (15.5%), fertilizer application (14.1%), pest and disease management (12.2%) water drainage management (6.6%), transplanting (4.0%), and seedbed preparation (2.7%). Statistically significant socio-economic factors affecting uptake of recommended practices for coffee were; Age [p=0.014], education level [p=0.002], labour [p=0.005], Farm size [p=0.001] , farming experience [p=0.031], Gender [p=0.031], land slope [p=0.048], Un-accessibility to credit services [p=0.032], Plot ownership [p=0.049]. Policy interventions were; farmer capacity building(35.1%), strengthening agricultural extension (23.7%), credit extension to the farmers (15.7%), re-visiting land reform policies (13.6%) group formation (11.9%). The study concluded that Coffee in the study area was grown under two production systems; intercropping and mono cropping, The major coffee recommended practices used were; seedbed management, transplanting, pruning, shading, fertilizer application, weeds control, pest and disease management and water drainage management. Socio-economic factors like Education level, shortage of labour, farm size, experience in farming, gender, slope of land, un-accessibility of credit services, farmer age and plot ownership type were significant socio-economic factors affecting uptake of recommended practices. Suggested policy interventions were; re-visiting land reform policies, credit extension, capacity building, strengthening agricultural extension and farmer group formation. More education and training for farmers, revisiting land policies, groups, associations and cooperative formation, credit services extension are recommended.

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

Coffee (*Coffea Spp*) is a genus of flowering plant in the family Rubiaceae. It is a shrub or small tree native to tropical, evergreen with multiple stems and smooth leaves and produce clusters of cream-white flowers and fruit commonly referred to as a berry which normally possesses two seeds and its one of the most important cash crops across the world and a major source of export earnings in developing countries (Kandji & Verchot, 2014).

Globally, coffee is second only to crude oil as the most important internationally traded commodity in monetary value and Brazil is the largest producer and exporter of coffee followed by Vietnam and Colombia (Kandji & Verchot, 2014). In spite of its high global export earnings, coffee producing countries more especially in Africa suffer a number of setbacks when it comes to coffee productivity and performance. The ever changing environment coupled within compatible and unsustainable management practices affects performance hence upsetting the overall production.

In African, Ethiopia is the largest producer of coffee but overall coffee yield in Africa is relatively little and fetches low prices compared to coffee from other continents (Mendez et al., 2010). As a result, most coffee farmers get lower incomes from coffee sales which do not help them out of poverty. To boost production, African governments have adopted different management practices that can enhance coffee productivity, for-example agro-forestry systems and other management practices have been approved to increase production while conserving a portion of the biodiversity that occurs in coffee farming systems. Such management practices balance the tradeoffs between farmers' economic needs, ecosystem services and biodiversity conservation (Hundera et al., 2012).

In Sub-Saharan Africa, coffee is a major cash crop and source of income to farmers (Sannen et al., 2014). In spite of its economic importance, the productivity of the crop is currently under threat posed by inappropriate management, declining soil fertility, pests and diseases (Jassogne et al., 2013). Minimal use of recommended management practices contributes to low coffee performance hence affecting productivity (Allan et al., 2015). In coffee production, appropriate management practices are key if plant productivity must be achieved. Sustainable management involves the adoption of appropriate recommended land management practices that enables land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources (Batary et al. 2011). There are various recommended management practices for crop survival and production but Sub-Saharan African governments are still reluctant in investing in such technologies perhaps due to high capital investments, lack of technical manpower, insufficient technology, overdependence on human labour and negative reception from the community.

In Uganda coffee is cash crop and Uganda ranks seconds in Africa after Ethiopia. Agriculture contributes 22.6% of GDP (UBOS, 2015), and 90% of foreign exchange earnings (Charlesetal.,2013). Coffee is currently dominating the agricultural sector in Uganda as a source of income in terms of exports. The crops are the main source of livelihood to a large portion of the population. Specifically, coffee is the major export crop in Uganda employing over 3.5million families through coffee-related activities (UCDA, 2012). Arabica coffee production systems are concentrated and intensive in high land areas. These regions account for 40% of the total coffee volume produced in Uganda (Jassogne *et al*., 2013). Production in Uganda is however under threat from a combination of constraints including: poor management practices and declining soil fertility (Jonsson *et al.*,2012). These factors trap the smallholder coffee farmers who depend on the crop for their livelihoods in a vicious circle of low incomes and poverty. In addition, many soils are degraded due to the intense cultivation and erosion arising from high population densities and the overexploitation of natural resources (Munyuli, 2010).

The use of appropriate land use practices is therefore paramount in mitigating the effects of such shortcomings. These include fertilizer application, agroforestry, a traditional management practice which improves adaptability through simultaneous production of food, fodder and firewood (Jassogne *et al.,* 2013). Appropriate management practices (such as; agroforestry, fertilizer application, weeding, pruning, pest and disease control) have the potential to buffer against current climate variability risks due to their ability to provide ecosystem services. The major goal of recommended management practices therefore has been to develop economically viable agro-ecological system and to enhance the quality of the environment for coffee crop performance (Mugisha & Alobo, 2012). Although recommended management practices have showed potential on coffee productivity, uptake and use of these practices in Uganda has remained very minimal due to a number of unknown social, economic and institutional factors.

In Rubirizi district, coffee farming helps farmers generate incomes through marketing coffee. Coffee farming has been promoted as part of the strategies for poverty alleviation through income generation (MAAIF, 2010). It is a major source of farmer's income in the district and it has helped on poverty reduction across the district (Mugagga & Buyinza, 2013). To increase in coffee productivity in the area, a number of management practices have been promoted by National Agricultural Research Organization (NARO), but they have not been fully embraced by majority farmers causing stagnation in the coffee yields (MAAIF, 2010).

1.2 Statement of the problem

Coffee is one of the most important cash crops in Uganda and a major source of income to many smallholder farmers. Achieving maximum production and productivity requires that farmers apply proper management practices since quantity and quality of the crop relies on management practices used (Jassogne *et al*., 2013). Rubirizi is one of the districts where coffee is grown in Uganda. The crop plays a critical role on poverty alleviation by boosting farmer's income (Mugisha & Alobo, 2012). To boost productivity in the area, government through National Agricultural Research Organization (NARO) promoted a number of management practices aimed at doubling coffee production. However, farmers continue to register low coffee yields (average harvest 0.5kg of Fairly Average Quality per tree instead of 2-4kg) hence affecting their livelihoods and incomes (MAAIF, 2010; UCDA, 2012). Efforts to promote the right management practices to enhance productivity have remained futile as farmers have continued relying on traditional unsuitable practices which yield poorly (Mugagga & Buyinza, 2013). Studies done in other areas linked the use of management practices to socio-economic factors like land size, labour availability, access to credit and extension information etc (Allan et al., 2015). It remains unclear whether these very factors apply to the current study area given that no empirical study has been conducted on the phenomena. The current study was conducted to fill the gap and hence delved into the factors limiting farmer's utilization of recommended management practices for improved coffee productivity in the area.

1.3 General Objective

The main objective of the study was to assess the coffee production recommended management practices used and identify factors influencing their uptake and utilization in Kichwamba and Kirugu sub-counties.

1.3.1 Specific Objectives

1. To identify the coffee production systems and practices used by farmers in Kichwamba and Kirugu sub-counties.

2. To identify the socio-economic challenges associated with the uptake of recommended practices for coffee production in Kichwamba and Kirugu sub-counties.

3. To determine the policy interventions to address the challenges associated with use of recommended coffee management practices in the area.

1.4 Research questions

1. What are the coffee production systems and practices used by farmers in Kichwamba and Kirugu sub-counties?

2. What are the socio-economic challenges associated with the utilization of recommended practices for coffee production in the area?

3. Which policy interventions can be used to address the challenges associated with use of recommended coffee management practices in the area?.

1.5 Justification of the study

Rubirizi is one of the districts in Uganda with tremendous potential for coffee production given her soils, favorable climate, rainfall patterns, political support and farmers' enthusiasm for increasing production and household income (NAADS, 2004). Coffee is not new to the districts' farming system though is still hampered by a number of challenges, poor performance, pests and diseases which greatly affect sustainable production. There have been so many studies done on coffee and have mainly focused on management practices, pest and disease control, climate impact on production however other important aspects like the factors associated with the uptake and utilization of recommended management practices for improved coffee production and performance remain understudied. There were still gaps in studying the factors associated with the utilization of recommended management practices yet identifying and addressing such factors could transform the coffee sector from traditional to innovative production.

1.6 Scope of the study

1.6.1 Content scope

The study focused on the factors limiting farmer's utilization of recommended management practices as independent variable and coffee productivity as dependent variable. It specifically; identified the coffee production systems and practices used by farmers, identified the socio-economic challenges associated with the utilization of recommended practices and identified the policy interventions to address the challenges associated with use of recommended coffee production practices.

1.6.2 Geographical scope

The study was conducted in Kichwamba and Kirugu sub-counties, Rubirizi District. Rubirizi District is bordered by Kasese District to the north, Kamwenge District to the northeast, Ibanda District to the east, Buhweju District to the southeast, Bushenyi District to the south, Rukungiri District to the southwest and the Democratic Republic of the Congo to the west. The district headquarters at Rubirizi are located approximately 90 kilometres (56 mi), by road, northwest of Mbarara, the largest city in Ankole sub-region. The coordinates of the district are: 00 16S, 30 06E. Agriculture is the mainstay of the district's economy. The fertile soils and good climate has allowed adequate produce of food crops for home consumption and cash crops for sale. However, because the district is located mountainous terrain, bringing the produce to market remains a challenge and a constraint to increased production. The main economic activity is small scale subsistence agriculture with food crops like rice, maize, sweet potatoes, bananas, millet, cassava and cash crops like coffee and cotton (NAADS, 2004).

The sub-counties selected are one of the leading producers of coffee in the district and two varieties of coffee (Arabica and Robusta) are grown. Rubirizi district is also one of the beneficiaries of the national coffee replanting programme by UCDA that has targeted reviving the coffee sub-sector. The district has many small scale coffee factories that are used by coffee traders to hull their coffee, sort and grade and finally sell to exporters. Agriculture is the mainstay of the district's economy. The fertile soils and good climate has allowed adequate production of cash crops like coffee for sale.

The farming system

The farming system in the district is characterized by mixed farming involving crops and animals. The agro-climatic condition is favorable for growing diversified crops and rear different species of animals. The average farmland size per household is 0.5-1.0 hectares (WARDO, 2008/9). Coffee, banana, maize, sorghum, beans, millet and soya bean are some of the dominant crops grown in the area.

Climate

The district experiences frequent rainfall, and hence moisture stress is not a problem for their agricultural production. It has a bimodal rainfall distribution in the dry season of which a maximum average annual rainfall is estimated at 1400 mm. The maximum annual range of temperature, which is recorded in rainy season, is 25˚c while the minimum annual temperature recorded during dry season is 30^0 c.

1.6.3 Time scope

This study evaluated literature for a period of 8 years (2010-18). It was during this period that commercial coffee production in Rubirizi District has been increasing among rural farmers. Also in this period the Government of Uganda had transformed Plan for Modernization of Agriculture (PMA) and Poverty Eradication Action Plan (PEAP) into National Development Plan to meet national goals and objectives of eradicating household poverty and increase food security among the farmers. It was again in this period that Government of Uganda has fully reorganized coffee production as one of the major interventions for fighting poverty (NAADS, 2004).

1.7 Significance of the study

The findings will be of great importance to the Ministry of Agriculture, animal industry and fisheries (MAAIF) by using this research to disseminate information to farmers so as to improve on their coffee production which will enable them generate more income for growth and development of their households. The findings of this study will be of paramount importance for coffee farmers, and other farmers who would wish to start coffee growing in the sub county by helping them acquire necessary information on management practices needed improve coffee production.

The study findings and recommendations are hoped to generate both practical and theoretical awareness important to other researchers, policy formulators, policy implementers, coffee Cooperative Societies, coffee factory Management and coffee stakeholders in revitalizing coffee sector.

The findings will assist the Government and individual farmers in decision making as to which factors to give more priority so as to increase coffee productivity. This is likely to assist in providing greater insight into the production and factors that contribute towards coffee productivity.

The study will also form the ground for replication by development practitioners while designing coffee revival projects. It is also hoped to provide basis for further studies and also documenting factors affecting low coffee production within the country and beyond which may hasten realization of 20m coffee bags by 2025.

1.8 Theoretical Framework

The conceptual framework presented here is based on the theory of agricultural household models (Asenso-Okyere and Jemaneh, 2012). According to these models, decisions of a farmer to use a technology in a given period are assumed to be derived from the maximization of expected utility subject to limitations. In what is called the characteristics theory of consumer choice", Todorovic and Filipovic, (2010) argued that goods are as good as their desirable and undesirable characteristics, and their attributes embedded there in give rise to utility. Drawing from this model, farmers' utilization recommended management practices is derived from the benefit that farm households derive from practice (Abebe et al., 2013). Therefore, use of recommended practice is derived from the costs and benefits of the practice (Birol and Melinda, 2009). Farmers are unlikely to adopt a practice if it fails to offer the benefits that they demand.

In this study, farmer's uptake and utilisation of recommended management practices and associated factors are incorporated into the analysis of early-stage adoption decisions. Not only adoption, but also rejection (before or after use) of a practice can be explained by using the characteristics model. For instance, according to Katungi, et al., (2011), users would reject a technology that is not relevant to their needs and not suited to their work environment.

Education, age and other respondent characteristics were included in the model. Technically, information acquisition, as well as the capacity to process, understanding and using the technical aspects and returns related to alternative and complementary technologies, is largely determined by formal education, age and level of awareness. Hence, educated farmers are often more likely to adopt a new technology (Birol, and Melinda, 2009).

The effect of farmers' age could be positive or negative, depending on their position in the life cycle. Both age and age-squared are included in the model because they allow for diminishing or increasing effects of the additional year of age. By including age-squared, the effect of age is allowed to vary across different age brackets (Ajewole, 2010). Farmers' age may influence adoption in various ways. Older farmers may have more experience, resources or authority that would allow them more possibilities when trying a new technology (Chigeza et al., 2013). They may have more experience in farming, more indigenous knowledge and better skills to assess the characteristics of modern technology. However, it could also be that older farmers are more conservative (risk averse). They might want to continue with old methods and techniques, giving less value to the proven farming practices. That is why the expected sign remains an empirical question (D’Hont et al., 2012).

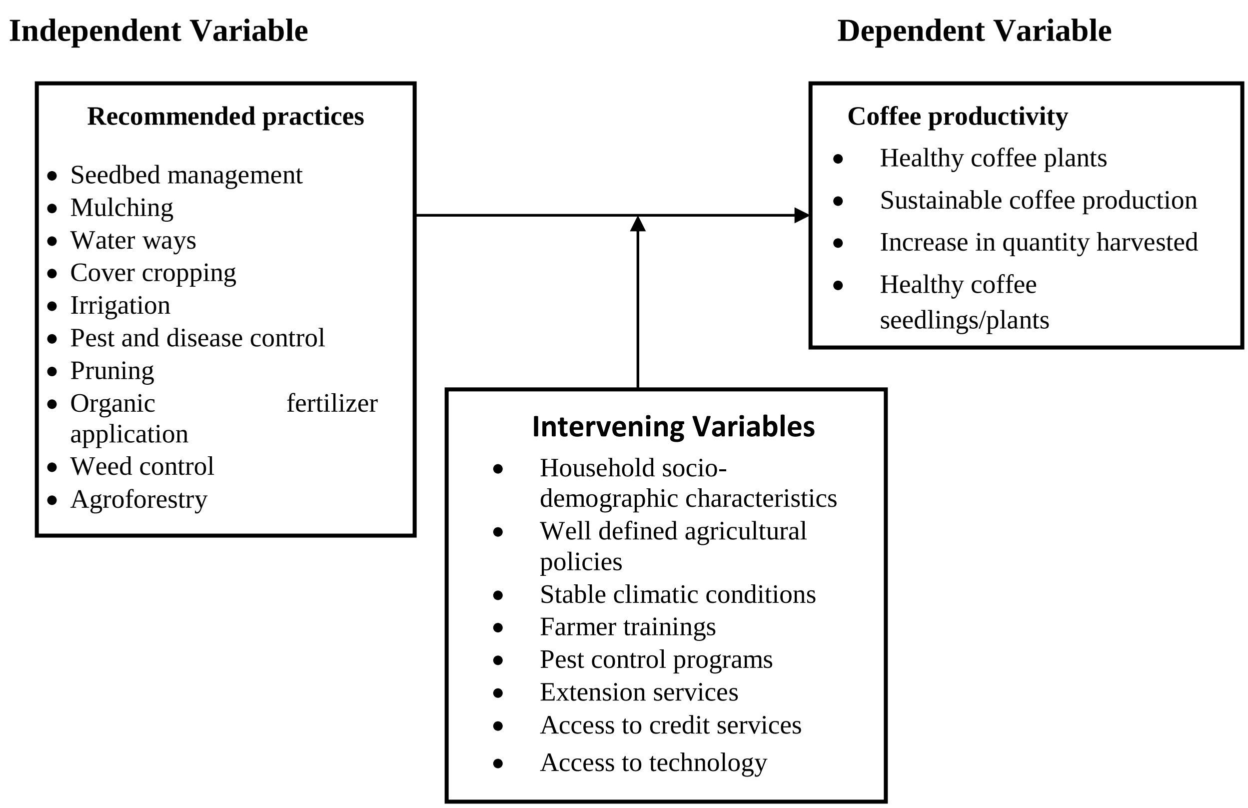
Access to extension services is often regarded as one of the most important sources of information for agricultural production (Aguilar, 2013). The number of extension visits received by a farmer is expected to be positively related with the response variable.

Regarding gender, it is hypothesized that male farmers are better able to adopt utilize recommended practices than women. Based on previous empirical adoption studies (van Asten et al., 2011), women are more constrained to accumulate assets, and have limited access to productive resources such as credit and land. Consequently, their access to improved technologies is negatively affected.

1.8 Conceptual framework

A conceptual framework (CF) is a couple of facts linked together which assists to provide guidance towards realistic collection of information as defined by Maman*et al* (2002). The conceptual framework underlying this study was based on farmer's use of management practices for increased coffee production. It was hypothesized that farmers who did not apply recommended management practices had less chances of coffee survival and quantities of coffee produced. The study looked at management practices as the independent variable and productivity as the dependent variable (Norman, 2013).

Figure 1: Conceptual framework



CHAPTER TWO: LITERATURE REVIEW

2.1 Coffee production

Globally, Brazil leads in coffee production globally followed by Vietnam and Colombia NUCAFE, (2018). Uganda is ranked number seven in the whole world and second only to Ethiopia among the Africa, Caribbean and Pacific (ACP) countries and Number one in Common wealth nations (De Beenhouwer et al., 2013).

Uganda produces two types of coffee: Arabica coffee (*Coffeaarabica*), which comprises about 70 per cent of the world's coffee production and 10 percent of Uganda's coffee production; and Robusta coffee (*Coffeacanephora*), which comprises about 30 per cent of the world's production and 90 per cent of Uganda's production (UCDA 2012). Robusta coffee is indigenous to the central parts of the Uganda, while the British colonial authorities introduced Arabica coffee at the turn of the twentieth century. Robusta is grown in the central part of Uganda in the Lake Victoria crescent, and across the west, south-west, and east of the country. Arabica is grown at a higher altitude, in the areas of Mountain Elgon along Uganda's eastern border with Kenya and in south-western Uganda along the Rwenzori mountain range (UCDA, 2012). Robusta beans are uncharacteristically hard, giving them good roasting qualities. They have a mild, soft, sweet and neutral taste, and have high frothing properties suitable for popular drinks such as espressos. Uganda's Arabica also has strong market qualities; it is wet processed (washed) to produce a mild coffee that is popular with most consumers.

2.2 Coffee production systems and practices used by farmers

2.2.1 Coffee Production Systems

Globally, coffee has traditionally been cultivated in the shadow of dense tree canopies of native trees, a so called rustic management system (Jassogne et al., 2013). Coffee cropping systems can be categorized due to different levels of shade. The amount of shade coffee systems has decreased in Colombia and worldwide since the 1970s in favor of more intensified low shade systems (Hulme et al., 2012).

In Latin America, trees incorporated in agro ecosystems, so called agroforestry, can provide a range of ecological benefits. Below ground, the roots of the trees penetrates the soil deeper than the roots of smaller plants which affects soil structure, nutrient cycling and soil moisture conditions. Trees can also benefit the agro ecosystem by forming symbiotic relationships with mycorhizza which can increase nutrients uptake from the soil, and leguminous trees can contribute with nitrogen to the system which they are part of (Hulme et al., 2012). By absorbing nutrients from deep soil layer, trees can increase nutrient cycling and reduce the need of synthetic fertilizing. Above ground trees affects the solar radiation and creates a microclimate under its canopy, which can stabilize temperature conditions, which in turn affects humidity and evapo-transpiration (ITC, 2012). The canopy of the trees can also protect crops from heavy rains and strong winds and thereby reduce erosion. Tress incorporated in agro ecosystem increases biodiversity and provides habitats for different organisms which can make possible a more stable population of pests and their predators (Jassogne et al., 2013). Shed leaves makes up a good soil cover which benefits soil living macro- and microorganisms which transforms plant residues to humus.

Mwaniki, (2014) reported positive aspects of incorporating trees in coffee plantations according to several farmers improved soil quality and incomes derived from the trees. The benefit of shade trees is less sickness in the coffee cultivation and that the coffee beans in his shade coffee field gets bigger seeds, with better quality after drying. Shade trees can give a better microclimate, and that this is important in hotter areas than the area of his farm, and referred to the shaded coffee farms in a hotter part of Colombia where he comes from (Mugagga et al., 2013).

In forest coffee systems of Bale Mountain Ecoregion (BMER), farmers traditionally managed forest coffee in three different systems (forest coffee, semi forest coffee and garden coffee) to increase coffee density and optimize its productivity (Läderach et al., 2011). The conversion of a forest coffee system into a semi- forest coffee system affects the floristic composition and diversity of plant species in the forest (UCDA, 2012). Studying population size structure of plant species based on the outcome of past demographic events provides valuable information as an indicator of its demographic future (regeneration/recruitment status) for devising evidence based sustainable management, use and conservation (Ndinomupya., 2010).

In Uganda, smallholders operate small coffee farms that generally support a single extended family (Mugagga et al., 2013). The main type of coffee produced in Uganda is Robusta, which grows well at an altitude of 2,900 to 5,000 feet (Jassogne et al., 2012). Uganda has approximately 500,000 smallholder coffee farms. Each has less than 2.4 acres of land. Many farmers depend on the coffee crop as their main source of income. On many farms, coffee is intercropped with plantain, which is a main staple food. A variety of other crops, including several bean types, also might be planted in the coffee garden or separate fields (Mugisha and Alobo, 2012).

Garratt et al., (2011) emphasized that in Uganda coffee is either grown in pure stand or intercropped with banana plantain. Newly planted coffee trees are intercropped with leguminous cover crops like soybeans, groundnuts and non-climbing/bush Phaseolus beans, up to two years. If intercropped with bananas, plant at a ratio of four coffee trees to one banana, (banana at 20 by 20feet in Robusta and 16 by 16feet in Arabica starting from the middle of four plants at the beginning of the garden).

Fruit trees such as avocado, mangoes and jackfruit are also be used. The importance of shade is to reduce weed growth, soil temperature, water loss from the coffee trees, leaves that fall from shade trees act as mulch and roots bring up nutrients that may have leached to the sub-soil and protect coffee trees from being broken by heavy wind (act as windbreaks (Batary et al., 2011).

Agroforestry systems (AFS) have the potential to be productive while conserving a portion of the biodiversity that occurs in natural ecosystems (Hundera et al., 2012). Agroforestry can balance the tradeoffs between farmers' economic needs, ecosystem services and biodiversity conservation (Sannen, Gulinck, and Vranken, 2014). AFS provide a refuge for biodiversity, can supply other environmental services, and are suitable for agro-ecological research (Mendez et al., 2010). Different management practices and shade tree species have contrasting effects on AFS productivity and on associated biodiversity (Mugisha and Alobo, 2012). In agroforestry experiments plant species diversity, species composition and management practices can be manipulated or adjusted at a relatively low cost (Allan et al., 2015).

2.2.2 Coffee production management practices

2.2.2.1 Planting Material and selection of seeds

Based on a good selection of planting material, producers can expect the productivity and yields they require. Most producers choose their own seeds each year to establish new plants and / or to replant. The selected seeds come from mother plants with the following characteristics; pest and disease free, aged between 7-12 years, well developed and uniform bean size, plantation must be at optimum productivity stage, the plant is well loaded with fruit, the plant is vigorous and plants with recommended agro-ecological conditions (Kandji and Verchot, 2014).

Other activities to ensure quality seed selection

- Select only healthy beans that have reached full maturity and that are located in the middle part of the tree (on primary or secondary branches) and in the middle section of each branch.
- Flotation. Once harvested, producers must place selected beans in water and eliminate those which float, as these are not productive. This is a first step in selecting which seeds to use.
- Pulping. Subsequently, producers de-pulp the selected seeds. It is recommended that this activity be done by hand to avoid damage to the seeds.
- Fermentation: This activity takes place in concrete tanks, wooden crates or jute bags. The recommended fermentation time is 8-12 hours in order to not affect the germination of seeds, but can be extended for up to 18 hours in areas with lower temperatures.
- Washing and drying: After the fermentation process, thoroughly wash seeds in clean water. Deformed seeds are eliminated, as well as small, misshapen, or those with insect

bites. Only the largest and uniform seeds are selected for drying, which is done in small wooden boxes and under some shade until seeds have dried to 18-20% moisture.

2.2.2.2 Establishment and management of seedbed

Constructing the seedbed

Germination banks require fertile soil mixed with sifted and washed river sand, from which all stones, roots and other foreign material that may affect the development of the seedlings have been removed (Sannen et al., 2014). The recommended proportions are 75% sand and 25% soil. The use of sand provides a structure for good root growth and ensures proper root development prior to transplanting.

Size of the seedbed

The seedbeds should be 1 meter wide, 20 centimeters high and whatever length is desired by the producer. One meter in length is generally enough for planting one pound of seeds, which generally produces 1000 seedlings. However, the specific number of seedlings will depend on the variety of coffee. When more than one germination bank is built, there should be 40 to 50 centimeters between each one, to allow for sufficient space to walk between (Kandj and Verchot, 2014).

Planting the seeds

Prior to planting, the seedbeds should be well watered and prepared. Using a rake or stick, the seedbed should be leveled and furrows of 1.5 - 2 cm deep should be made, leaving 5-7 cm between each furrow (Ndinomupya, 2010). The seeds are then deposited into the furrows, evenly spaced together yet preventing them from being clumped together too much. The seeds are then pressed slightly into the ground and covered with disinfected soil. After planting, the seedbeds should be covered with a layer of dry chopped (seedless) grass, Spanish moss or clean used jute bags. This is done to ensure that seeds are not uncovered when watered.

Seed bed management

Care should be taken each day when watering the seedbed. This should be done in the early morning hours, using a watering can to distribute the water evenly (Läderach,et al., 2011). Producers must constantly monitor the seedbed to identify problems and take corrective action in a timely manner. Care should be taken each day when watering the seedbed ((Mwaniki, 2014). This should be done in the early morning hours, using a watering can to distribute the water evenly. Producers must constantly monitor the seedbed to identify problems and take corrective action in a timely manner. In addition, shade and moisture levels in the seedbed should be monitored and regulated.

Transplanting the seedlings

Transplanting of seedlings should take place between 60 and 90 days after planting. This task should be done with the greatest possible care. To easily remove the seedlings and not harm the roots, the seedbed should be thoroughly watered first (MAAIF, 2010). Only the healthiest and strongest plants with well-formed roots should be selected for transplanting.

2.2.2.3 Establishment of coffee nursery

Nursery Design

To ensure quality, plants must be placed in rows or banks of 1 meter in width and up to the length required for the number of plants a producer will plant. Rows or banks can be formed with 3-6 rows of bagged seedlings, leaving a space of at least 1 inch between each row. The space between banks should not be less than 50 centimeters, as this is the necessary space required to assist in the management of the plants (Ndinomupya, 2010)

Preparing the soil for filling bags

To prepare the soil needed for filling the polyethylene bags, loosen 20 cm of topsoil which has not grown coffee previously and is rich in organic matter (Vandermeer et al., 2010). This soil has to be loose, without stones, roots and all other foreign material. As a suggested step, the soil can be sifted through a sieve to ensure uniformity in particle size and uniformity. The soil should be mixed with coffee pulp, cow manure, vermicompost, bokashi, bat guano, compost, lime or ash in order to disinfect it. These additives also assist in preventing plant loss and promote vigorous, healthy plants which are resistant to coffee rust, pests and other diseases, but also in increasing productivity potential.

Timing for nursery preparation

Nurseries should be prepared no later than the beginning of March to April of each year. The coffee seedlings should be placed in 6x8 inch polyethylene bags (Läderach et al., 2011). The recommended final transplanting should be around 4-5 months to avoid excessive root growth in the bags and / or require their pruning. To transplant, coffee plants must have 4-5 pairs of leaves. (Two photos of plants ready to transplant). In areas where irrigation is available, the nursery can be established in February, ensuring that the plants are ready for final planting in June.

Transplanting the coffee seedlings to bags

For transplanting the seedlings to polyethylene bags, the following recommendations should be taken into consideration:

- The seedlings should be transplanted on cool days, first thing in the morning or later in the afternoon, ensuring that the soil in the bags is wet.
- The depth of the hole must be greater than the length of the root of the seedling.
- The coffee seedling should be planted with the root in a straight downwards direction, as when it was still growing in the seedbed.
- Firmly press down on the soil around the base of the plant with the planting stick to expel any air pockets around the roots.
- At the time of transplanting, apply 5g of mycorrhiza to each plant, directly to the roots of the seedlings.
- Once the plants are transplanted, they must be watered thoroughly.

While the plants are in the nursery, it is essential to water the plants every day during the dry season and as needed during the rainy season.

Nursery management

To help plants grow better and resist attacks by disease, it is recommended to weed for unwanted plants, water regularly, apply foliar sprays made from livestock manure, honey water mixed with minerals, vermicompost and natural fertilizers strengthened with minerals (Zn, B, Mg, Mn, or K) or rock flours of different colors. Producers can also apply other mineral sprays based on sulpho-calcium, ash, Visoca or Bordeaux mixtures depending on the type and incidence of disease (Läderach et al., 2011). (See on Pests and Diseases). Care must be taken to not exceed the appropriate dosage when preparing these sprays, so as to not poison the young coffee plants. As the plants grow, regulating shade begins at two months from transplanting, at which point sunlight is gradually allowed to enter, until completely removing all shade. This ensures that plants develop and adapt to local conditions upon final transplanting. Keep in mind that on certified organic farms, the seeds and vegetative materials used must be organically produced. Only if these are unavailable in the market, can non-organic seeds that have been treated with prohibited products be used, as long as permission from an accredited certifier, such as BIO LATINA, is received.

2.2.2.4 Establishment and management of a Coffee Plantation

Both Arabica and Robusta follow the same agronomic practices: planting materials and land preparations, field planting and management and pest and disease control. Coffee has a defined production cycle. In order to maximize yield potential of coffee, timely manipulation of the physiological features of the coffee tree through agronomic practices are necessary (Mwaniki, 2014).

Land preparation

Land preparation is critical for coffee establishment (Mwaniki, 2014). The first step involves clearing trees and/or slashing shrubs followed by burning. This is followed by marking the land and digging planting holes according to desirable design and density specifications. For Arabica, there is a relationship between yield and the size of planting holes: the bigger (0.9m x 0.9mx 0.9m) the hole, the higher the yield. Planting materials of coffee are propagated using various methods: seeds, cuttings, budding, grafting, layering and somatic embryo (Munyuli, 2010).

Field management practices include pruning, shading, fertilizer application, weed control, pest and disease management and drainage. Coffee is a perennial crop and has a production cycle. Therefore, coffee management should be dictated by the coffee calendar (Munyuli, 2010).

Pruning

Pruning is removing vegetative parts of the coffee tree in order to concentrate vigour into certain parts of the tree (MAAIF, 2010). Coffee bears well on a one-year old wood; therefore the coffee trees should be pruned routinely for maximum yield. The benefits of pruning include: (i) promotes production of healthy bearing laterals and/or uprights by removing unproductive parts of the tree; (ii) maximizes production; (iii) reduces pests and diseases infestations; (iv) promotes easy harvesting by reducing the height; and (v) facilitates easy application of other management practices such as spraying. There are three main pruning systems: (i) single stem; (ii) single stem free growth; and (iii) multiple stem pruning. The terms single and multiple stem do not refer to the number of bearing uprights. However, the main difference between single stem and multiple stem is that single stem system has restricted height and a permanent framework while a multiple stem system has trees with no restricted height and permanent framework. Although a single stem pruning system can have two bearing uprights, all forms of single stem pruning have restricted heights through capping to form an umbrella shape and the cherries are encouraged on the primary, secondary, and the tertiary branches, while in a multiple stem pruning system, cherries are borne mainly on primary branches (MAAIF, 2010).

Fertilizer application

In both the smallholder and estate sector, depletion of nutrients in coffee soil is high during harvest and recycle pruning where the beans and the wood respectively are taken out of the farm. An estimated 35 kg of Nitrogen, 7 kg of P_2O_5 and 50 kg of K_2O is removed from the soil when 1 tonne of green bean coffee is harvested. In addition, Nitrogen is lost during leaching and phosphate is lost through fixation. Therefore, unless these nutrients are replaced, the quality of the coffee beans will be affected (Sannen et al., 2014). Application of organic materials such as stable manure, leguminous plants, leaves, mulch, garden residues, ash and coffee pulp should be applied to the coffee trees for they contain minerals that could replace the nutrients that are lost during picking and pruning (Kandji and Verchot, 2014).

Weed control

Weed control is important in coffee to avoid competition for moisture, nutrients, space, sunlight, and to minimize the spread of pest and disease (Kandji and Verchot, 2014). If weeding is neglected, coffee yields will be depressed and poor quality will result. control is important in coffee to avoid competition for moisture, nutrients, space, sunlight, and to minimize the spread of pest and disease. If weeding is neglected, coffee yields will be depressed and poor quality will result

Shade trees

The option of growing coffee under shade is determined by coffee variety, climate, management style and locality (Garratt et al., 2011). Albrecht et al., (2007) highlighted the advantages and disadvantages of having coffee under shade. Advantages of shade include: (i) maintains a constant temperature, thus controls rate of photosynthesis, which leads to control in flowering and fruiting, leading to minimizing overbearing dieback; (ii) controls erosion and minimizes leaching through leaf litter and deep root systems; (iii) reduces weed density through leaf litter, reducing labour cost associated with weed control; (iv) intercepts leached nutrients by the deep root systems which are eventually added to the top soil through decaying leaf litter; (v) breaks the hard pans by the root systems of the leguminous trees, hence improve drainage of the soil;

and (vi) provides firewood, timber, and cash through selling wood and timber. The disadvantages are: (i) compete with coffee for moisture, nutrients, space, and light; (ii) requires hired labour for pruning; (iii) damages coffee trees during pruning, thinning, and felling; (iv) dense shade trees promote etiolated and weak branches of the coffee trees which result in few cherries; and (v) reduced yield due to reduced flowering, fruit setting and response to nitrogen is limited.

Pest and disease control

Pests of coffee include insects, mites, nematodes, molluscs, birds, mammals and some weed species. Pests of economic importance to coffee are mainly insects (Albrecht et al., 2007). Coste identified scales as the most important economic pest of coffee. Diseases of coffee are caused by fungi, bacteria and viruses. Charles et al., (2013) indicated that fungi are responsible for many diseases of coffee and are classified under four areas: (i) rots (e.g. roots and collar), (ii) rusts (e.g. Hemileiavastrix, Hemileiacoffeicola and Cercosporacoffeicola), (iii) wilt (e.g. Carbunculariosis) and (iv) berry related diseases (e.g. Colletotrichucoffeanum). De Beenhouwer et al., (2013) identified two diseases caused by viruses: Blister Spot and Ring Spot. Galls on coffee roots are associated with bacteria. Batary et al., (2011) identified three main control methods of pests and diseases: (i) chemical; (ii) biological; and (iii) cultural. Cultural and agronomic practices have been the best approaches to deter development and/or spread of pests and diseases. Timely application of pruning systems, weeding, shade control, drainage and removing diseased trees and burning them on site and/or burying have been the important management practices.

Coffee Calender

The coffee calendar is a management matrix which schedules the timely application of agronomy practices in accordance to the coffee physiological changes (De Beenhouwer et al., 2013). Untimely application of farm inputs can result in expensive wastage. Therefore, understanding of the coffee production/development cycle is essential.

2.3 Socio-economic challenges associated with the utilization of recommended practices for coffee production

The socio-economic factors affecting farmers use of different recommended management practices for coffee productivity include the following; field support, age, gender, farm size, education, labour availability, access to extension services, plot ownership, capacity building programmes, off farm incomes and farming experience.

2.3.1 Farmer's age

There is a controversy in the literature when explaining the relationship between age and level of farmer participation in any new farm technology (Allan et al., 2015). Older farmers are rigid in adopting new technologies. Perhaps this is because of investing several years in particular practices, which makes them unwilling to risk by trying out completely new farming methods (Kandji and Verchot, 2014). Age of the farmer has a negative influence on use of management practices. Age is negatively associated with farmer participation in a new technology (Hundera et al., 2012).

2.3.2 Education

Higher education gives farmers the ability to perceive, interpret and respond to new information much faster than their counterparts with lower education (Kandji and Verchot, 2014).

Education negatively influence adoption of agriculture management practices (Munyuli, 2010). Education is found to be negatively related to adoption of soil and water conservation measures

(Sannen et al., 2014). Adoption of management practices requires understanding land preparation procedures thus; household heads with higher education levels have a higher probability of adopting new technologies (Uganda Coffee Development Authority, 2012).

2.3.3 Gender

The household head is the implicit key decisions maker for the household (Charles et al., 2013). Male-headed households in developing countries have a higher access to resources and information that give them greater capacity to adopt (Allan et al., 2015).

2.3.4 Farm size

Farmers who have large farms are more likely to invest in crop management practices. Farmers with more land can take more risks, including a relatively high investment required in order to protect crops against pests, hailstones, drought and excess rainfall (Allan et al., 2015). Studies on the impact of farm size on technology adoption are mixed because the relationship depends on many other factors such as fixed adoption costs, risk preferences, human capital, credit constraints, labour requirements and tenure arrangements (MAAIF 2010). According to Vandermeer et al., (2010) small farmers often farm more intensively and have more labour available per unit of land while larger farmers have higher transaction costs to acquire hired labour. While the higher labour availability per unit of land enables farmers to adopt more labour intensive technologies, smaller portions of land may also be a pressure to farm more intensively especially when there are few alternative employment opportunities.

2.3.5 Lack of field support

There is a general lack of field support to the farmers. Each extensionist covers a wide area making it difficult to visit all farmers (De Beenhouwer et al., 2013). The extensionists do not have enough resources, which it makes it even more difficult to visit the few farmers more often. Some farmers say that an extensionist never visit them. There is little, if any, follow up by extensionists to the farmers' fields. Should a farmer have a problem then he/she has to go and ask the extensionists. Access to extension services exposes farmers to new technologies and their potential benefits (Munyuli, 2010). In addition, contact with extension services gives farmers access to information on innovations, advice on inputs and their use, and management of technologies (Jassogne et al., 2013). In most cases, extension workers establish demonstration plots where farmers get hands-on experience and experiment new farm technologies. Consequently, access to extension is often used as an indicator of access to information (Mugagga and Buyinza, 2013). It is postulated that access to extension positively affects the participation in new agricultural technologies which requires extra knowledge.

2.3.6 Lack of technical support

Lack of technical support affects farmer's use of recommended management practices. In Zambia, a large proportion of farmers who had no contacts with agricultural support programs did not adopt coffee management practices (Batary et al., 2011). This is because even the little extension support provided is not aimed at the promoting management practices but is more focused on food crop production and other agricultural activities. This shows that it is not sufficient to have extension support but the aim or purpose of extension service should also relate to the continuation of conservation work.

The greatest constraint faced by poor farmers to use of recommended management practices are lack of knowledge, access to markets, certification, agricultural inputs and lack of organization. In order to overcome these constraints, there is need greatly investment in practice-oriented research, capacity-building and extension, improve accessibility to local certification schemes and harmonized standards as well as organic market initiatives and fair trade relationships (Batary et al., 2011). Developing these tools and services in order to enable participatory learning processes can lead to sustainable innovation within the rural communities thereby contributing to sustainable development (Jassogne et al., 2013). The level of participation to any technology depends on its net economic benefits in relation to other options but also on external constraints that may impede participation in profitable technologies (Sannen et al., 2014).

2.3.7 Labour

Labour is an important constraint in adoption of new technologies particularly those technologies that are labour-intensive (Vandermeer et al., 2010). Labour availability can be measured as the proportion of household members who contribute to farm work. The proportion of household members available to provide labour positively influence adoption of soil fertility management practices (VanAsten, et al., 2012). The number of household members who provide farm labour is positively associated with probability of participating in soil fertility management practices. Labour constraint negatively influenced farmer participation in improved tree fallows and other intensive technologies such as animal manure use (Mugisha and Alobo, 2012). Due to high labour demand for applying animal manure, households with high number of members working on the farm are more effective since household labour is the most important source of labour supply for smallholder households, given that low incomes constrain hiring labour. Moreover, there are moral hazards associated with hired labour calling for considerable supervision which raises the real cost of household labour beyond the observed wage rate.

Therefore, lack of adequate labour accompanied by inability to hire labour can seriously hinder participation in soil fertility management practices (Mugisha and Alobo, 2012).

2.3.8 Plot ownership

This is a proxy measure for assured land access and this has a positive impact on the decision to adopt conservation tillage methods (Allan et al., (2015). Ownership of land increases the assurance of future access to returns on investments. Decision to participate in conservation tillage indicated a positive impact of farm distance from the farmer’s homestead. This is because plots far away present tenure security challenges due to difficulties in monitoring. Consequently, farmers might invest more in them as a way of securing tenure (Charles et al., 2013).

2.3.9 Slope of Land

There is likelihood of households choosing to practice conservation declined with the perceived slope of the farm (Charlesetal., 2013). This reflects the fact that plots with steeper slopes are more prone to soil erosion which necessitates adoption of good soil management practices meant to mitigate soil erosion and subsequent nutrient losses. Sustainable agricultural systems are intuitively site-specific (Albrecht et al., 2007) and this further confirmed that plot characteristics influence the decision to adopt conservation tillage. The slope of land thus impacts the decision to combine use of compost and conservation tillage in a similar way. Thus, for sustainable agricultural practices to be successful, they must address site-specific characteristics in order to facilitate adoption as well as the type of technology to be adopted (Hundera et al., 2012).

2.3.10 Farmer’s Training

Training, motivation and capacity building programs influence adoption behavior of farmers in organic vegetable farming (OVF) (Hundera et al., (2012). Training and motivational programs conducted through the OVF promotion projects significantly contributed to the practice of organic vegetables. Similarly, membership in groups may expose individuals to a wide range of ideas and sometimes give farmers the opportunity to have better access to information which may make them have a positively attitude toward an innovation (Batary et al., 2011).

2.3.11 Off-farm incomes

Off-farm incomes have proved quite important in fostering participation of good soil management practices. Cash is essential in hiring labour and purchasing of farm inputs such as seeds and animal manure (DeBeenhouwer et al., 2013). Off farm incomes positively influence adoption of manure and compost use (Mugagga and Buyinza, 2013). Resource-poor farmers may not generate sufficiently investible surpluses in order to remain self-sustaining in the absence of non-farm incomes. Thus, farmers need off-farm incomes to invest in more sustainable agricultural intensification. Since cash is required to purchase inputs and hire labour to apply them, it is hypothesized that off-farm income positively influence adoption of good soil management practices (Munyuli, 2010).

2.3.12 Farming experience

This is another important household related variable that has relationship with adoption (DeBeenhouwer et al., 2013). Longer farming experience implies accumulated farming knowledge and skill, which has contribution for adoption. Many studies supported this argument. Kandji and Verchot, (2014) found the mean farming experience difference of adopters and the non-adopters is statistically significant. In contrary, a study Munyuli, (2010) found that farming experience had negative relationship with overall daily adoption. However, Mugisha and Alobo, (2012) reported that farming experience had no statistically significant relationship with adoption.

2.3.13 Access to farm tools

Access to farm tools is a critical factor that facilitates coffee management activities by the smallholder farmers (Mwaniki, 2014). Hence access to farm tools might motivate the participants to make better gains and is expected to have a positive relationship with the dependent variables.

2.3.14 Access to credit

Coffee management involves more use of inputs which have great cost implication. Credit is very much useful to purchase inputs such as improved seeds and other inputs (Vandermeer et al., 2010). Hence, access to credit is expected to influence the effectiveness of coffee management practices positively on the dependent variables.

2.3.15 Participation in training

Training is one of the means by which farmers acquire new knowledge and skill. It is measured as the number of times the farmer has received technology training in the last three years (Vandermeer et al., 2010). Hence, participation in training is expected to positively influence farmers' adoption behavior.

2.3.16 Contact with extension agents

Contact with extension agents is defined as the number of contacts per year for management technology that the respondent made with extension agents and it is a continuous variable.

Contact with extension agent is hypothesized to increase farmers' likelihood of adopting management practices The higher number of contacts the farmer have with extension personnel the higher the exposure to management knowledge, and the more likely the adoption (Batary et al., 2011).

2.3.17 Information seeking behavior

Information seeking behavior is the degree to which the respondent is eager to get new and valuable information from Farmer Field School and other sources on different roles he/she performs (Charles et al., 2013). This is measured in terms of how much information is sought, how frequently and from where the information is sought. This behavior is assumed to have positive relationship with the dependent variables.

2.4 Policy Interventions for addressing socio-economic impediments to the use of management practices for sustainable coffee production

2.4.1 Strengthening agricultural extension

Extension is involving the conscious use of information to help farmers make good decisions (Albrecht et al., 2007). Mendez et al., (2010) indicate that the role of extension is to educate the people to understand that they are an agent of change and are able to influence their communities by addressing their immediate problems through application of acquired technology. The process of extension education is one of working with people, not for them; of helping people become self-reliant, not dependent on others, of making people the central actors in the drama, not stage hands or spectators; in short, helping people by means of education to put to use useful knowledge that works for them.

2.4.2 Knowledge generation

Knowledge generation need be seen as a process and emergent questions are how poor, weak and vulnerable groups can be strengthened to experiment, enhance, share and spread their own knowledge and how they better can articulate their needs (Mugisha and Alobo, 2012). Though, having considered extension as mainly an act of transforming technologies to farmers there is now a focus on participations of farmers in the innovation process and facilitation of experimentation among communities.

2.4.3 Collaborative research

Collaborative research with farmers and research driven by farmers ensures such grounding in local needs, but also incorporates local knowledge of conditions, including both knowledge of local ecosystems, weather, etc., and local insight in labor availability, fit with the local farming system, local markets, etc (Munyuli, 2010). In this respect, one can say that the Farmers field school (FFS) has a high potential for taking local needs into account. But such locally driven demand is not automatic. FFS-based investments also can be used to promote practices that farmers are not in need of. Building of farmers' management and problem solving capacity requires joint learning through practical FFS work (Mugisha and Alobo, 2012). This requires a shift from previous perceptions where farmers were seen mainly 'adopters' or 'rejecters'' of technologies but as not as providers of knowledge and improved practices (Batary et al., 2011). Many studies have shown the ability among farmers to innovate and develop their own solutions to problems through FFSs, there by being part of the innovation system rather than just recipients (Allan et al., 2015). The development of solutions under their circumstances requires a new and more farmer oriented approach to problem solving and decision taking procedures, where farmers are involved in the entire process of searching and applying new solutions which may comprise both social and technical elements (Mendez et al., 2010).

2.4.4 Adopting top-down extension model

Top-down extension models involve the transfer of technology from a knowledge and technology reservoir to a potential adopter (Mendez et al., 2010). The technology reservoir may be an information and technology generator such as a research institute, university and/or a government department. Potential information adopters are the farmers. Examples of top-down models are: (i) Technology Transfer; (ii) Farmer Feedback; and (iii) Training and Visit. Impact of farmer group mobilization on technology adoption: One of the factors that encourage farmers to work in collaborative marketing groups (CMG) is the sense of security by members of the CGM in adopting new innovations. Individual farmers do not feel isolated in taking the risks associated with adopting new technologies, as the effect of adopting a particular innovation is felt by everyone in the group (Mendez et al., 2010). Sannen et al., (2014) indicated that empowering farmers entrepreneurially ensures that the technology is market driven. CMG can facilitate the delivery of innovations via training so that improvements in yield and quality are realized through the adoption of acquired innovations. CMGs are able to realize meaningful adoption of innovation through the formation of strategic alliances with local traders with the aim of producing better farm products (Munyuli, 2010).

2.4.5 Impact of infrastructure on technology adoption

Infrastructure plays a significant role in facilitating the adoption of technology by farmers (Munyuli, 2010). There are two main forms of infrastructure: hard and soft. Hard infrastructure includes roads, bridges, airstrips/airports and wharves. Soft infrastructures include banking, agricultural suppliers, research and extension, transport systems, and marketing outlets. Kandji and Verchot, (2014) indicated how the presence of a good road system often determines the prices that farmers receive. Communities that lack good roads are likely to get lower returns for their agricultural products. Poor roads also affect farmer accessibility to new innovations. Good infrastructure creates conducive environments for farmers to receive new innovations (Jassogne et al., 2012).

2.4.6 Impact of literacy on technology adoption

Educated farmers appear to be early adopters of technology and illiterate farmers tend to adopt innovations after observing from educated farmers (Mugagga and Buyinza, 2013). Generally, farmer training plays a role in increasing farm output and shifting the production frontier outwards. Allan et al., (2015) indicated that educated farmers have increased their ability to understand and evaluate the information on new products and processes and therefore are quicker to adopt innovations if they know that the innovations are profitable in the long run. Farmers in the developing countries adopt innovation by sharing and learning from each other and educated farmers becoming the catalyst for innovation diffusion among the illiterate farmers. Therefore, literacy plays a role in the acquisition, diffusion and application of innovation (Munyuli, 2010).

In spite of coffee's economic importance, its productivity is currently under threat posed by inappropriate management practices, declining soil fertility, pests and diseases (Jassogne et al., 2013). In coffee production, appropriate management practices are key if plant productivity must be achieved (Batary et al. 2011) but Sub-Saharan African governments are still reluctant in investigating why farmers are not up-taking these recommended management practices.

Therefore findings of this research will generate both practical and theoretical awareness important to other researchers, policy formulators, policy implementers, coffee Cooperative Societies, coffee factory Management, and coffee stakeholders in revitalizing coffee sector and most importantly findings of this study will be of paramount importance for coffee farmers, and other farmers who would wish to start coffee growing in the sub county and beyond by helping them acquire necessary information on management practices needed improve coffee production which will enable them generate more income for growth and development of their households.

CHAPTER THREE: RESEARCH MATERIALS AND METHODS

3.1 Research Design

The study employed a descriptive cross-sectional survey that used quantitative techniques for data collection. A survey is a means of gathering information about the characteristics, actions, opinions of a group of people, referred to as population. It describes data and characteristics about a population and phenomenon being studied. The descriptive survey design helped to answer the questions like who, what, where and how on describing the phenomenon on study. This design was appropriate for the study because it enabled sufficient data to be collected at one point in time from a sample which is selected to describe a larger population of coffee farmers. Qualitative approaches were used to collect and analyze views and opinions from key informants while quantitative approach involved the use of quantifiable methods to capture and analyze quantifiable information generated using a questionnaire. This enabled the researcher to draw from their respective strengths and gain a more comprehensive insight that informed both theory and practice.

3.2 Target population

Target population is the entire group a researcher is interested in or the group about which the researcher wishes to draw conclusions (Taylor and Zilberman, 2017). The study population included coffee farmers, local leaders and agricultural extension workers. Farmers were considered for their role in coffee production while key informants like local leaders and extension workers were considered for their closeness to the farmers and besides they were part of the group that implemented agricultural policies in the area.

3.3 Sample size determination

Study sample size was calculated using the standard statistical formula Yamane (1967) having known the number of respondents participating in coffee production from the Agricultural Officer's office Kichwamba Sub County. A sample size was calculated as follows:

$$n = \frac{N}{(1 + N * e^2)}$$

Where; n=sample size,

N = population size (obtained from Agricultural Officer database,

e= sampling error to determine the sample size

From Agricultural Officer database, the total number of coffee farmers in Kichwamba Sub County was 6,362 farmers. Therefore, applying the Yamane formula and using e=0.05.

$$n = \frac{6362}{(1 + 6362 * 0.05^2)}$$

The sample size (n) was 376.33 ≈ 376

A sample of 376 coffee farmers was used for the study

3.4 Sampling Procedure and technique

A multi-stage sampling procedure employing simple random and purposive sampling techniques was employed to arrive at the required number of respondents. Kichwamba and Kirugu sub-counties had a total number of 10 parishes and 24 villages. Of the 10 parishes in the two sub-counties, 2 parishes from each sub-county were randomly selected to make four (4) parishes in total. Out of the four parishes selected, 2 villages were randomly selected using piece of papers containing the names of the villages. A total of 8 villages were selected. The researcher with a help of village chairman got a list of all registered coffee farmers from each selected village with the aim of getting the required number of respondents at village level. A total of 47 respondents were randomly selected from each of the 8 villages to get a total of 376 respondents. Key informants including 2 local leaders, 1 District Agricultural Officer and 1 agricultural extension worker were selected with purposive sampling.

3.5 Research instruments

The study used self-administered questionnaires with (closed and open ended questions), observation and interview guide to collect primary data.

3.5.1 Questionnaires

A self-administered questionnaire with both closed and open ended questions was designed, translated to the local language and then used to collect data from coffee farmers. This method allowed a selected number of respondents to answer questions related to the study phenomenon. The answered questions were in line with the study objectives. The data collected was in relation to;

- Socio demographic characteristics like sex, age, education level, occupation, level of household income, household size, farm size, access to markets, access to credit and access to extension services, and decision making.
- Production characteristics like; type of coffee, quantities and costs of inputs used such as seed planted, land under cultivation of the coffee, coffee production systems, management practices, pesticides, fertilizers, output harvested, and quantity sold plus the prices.

- Socio-economic factors affecting farmers use of different recommended management practices for coffee production and performance in the study area.
- Community and policy interventions for sustainable coffee production in the area.

3.5.2 Interview guide

Interviews were conducted using an interview schedule that was administered by key informants. This involved oral or vocal questioning where the researcher became the interviewer and the respondents were interviewees. The interview schedule constituted of both open and closed ended questions. Interviews were preferred because majority of the key informants were busy with their work schedules. The interviews were used widely to supplement and extend the researchers' knowledge about individual (s) thoughts, feelings and behaviors. This method was suitable to capture data on such groups of people.

3.5.3 Direct Observation

Observation method is a method of data collection in which the situation of interest is watched and the relevant facts, actions and behaviors are recorded (Kawulich, B. 2005). During interview sessions, the researcher observed critically the agro-ecological farming practices being applied. Additionally, farmers were visited to assess the technology or combination of technologies used in coffee production. This helped the researcher to capture actual data through assessment. Observation method further helped the researcher to identify the challenges faced by farmers during use of different management coffee practices.

3.6 Quality Control Methods

3.6.1 Validity of Instruments

Validity was ensured by examination. Before administering the questionnaires, they were first examined by colleagues taking the same programme as the researcher. They were then scrutinized by the research supervisor. This ensured that the terms used in the questionnaire are precisely defined and properly understood. The instruments were then pilot tested on an appropriate population of 10 farmers.

3.6.2 Reliability of Instruments

An instrument is reliable if it measures consistently what it is supposed to measure. Even if it is administered by other researchers, it should produce the same results. In this study, the test-retest method was used to establish the instruments' reliability.

3.7 Procedures of data collection

An introductory letter was obtained from the directorate of graduate studies, research and innovation introducing the researcher to the relevant authorities to allow him carry out the research in the area of study. The introductory letter was then presented to the sub-county authorities who introduced the researcher to the lower local political entities like parishes, villages and families who included the respondents for the study. Plans were made, dates and convenient time fixed and steps taken to collect data.

3.8 Data analysis

3.8.1 Analytical methods for quantitative data

Data collected was coded, entered and cleaned using the excel computer program. A summary of descriptive statistics (percentages, means, standard deviations and t-statistics) were generated. Data was then transferred to Statistical Package for Social Scientists (SPSS) version 22.0 in which logistic analyses were carried out.

Objective one which was to assess the coffee production systems and management practices used by farmers in the area. Descriptive statistics of coffee production systems and management practices were generated using frequency counts and percentages.

Objective two was to identify the socio-economic factors affecting farmer's use of different recommended management practices for coffee production and performance in the study area. This was achieved using the logistic model. The assumption was that not all farmers are faced 100% the factors. Thus, the dependent variable (is dichotomous 1 for those experiencing the factors and 0 for those not experiencing). This study employed a generalized binary logistic model and specified as;

$$\log\left(\frac{\mathrm{p}}{1-\mathrm{p}}\right) = a + \mathrm{b}_1 x_1 + \mathrm{b}_2 x_2 + \mathrm{b}_3 x_3 + \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots + \mathrm{b}_n x_n + e \ldots \ldots .3.2$$

Where; p = is the probability of success

α=is the coefficient on the constant term

b_i=is the coefficient(s)on the independent variable(s)

x_i=is the independent variable(s)

e=is the error term

Objective three was to identify interventions for addressing socio-economic impediments to the use of management practices for sustainable coffee production in the area. Descriptive statistics of community and policy interventions were generated and presented using frequency counts and percentages.

3.9 Ethical considerations

The free and informed consent of each individual participant was obtained at the start of the study. Respondents read an informed consent form that explaining; the purpose of the study, what participation in the study involved, how confidentiality and anonymity would be maintained, and the right to refuse to participate in the study or to withdraw from the study without any penalty, the benefits and risks of participating in the study. Study participants were not required to undergo any invasive procedures. Personal / sensitive issues were explored when a good relationship was established with the informant. The research team were urged and required to respect the culture of the respondents during the data collection process. Confidentiality and anonymity was maintained by the use of code numbers on the questionnaire other than names. Information obtained was only used for the purposes of this study.

CHAPTER FOUR: RESULTS PRESENTATION AND DISCUSSION

4.1 The response rate

All the 376 sampled respondents were accessed for data collection giving 100% response rate. This response rate is above the minimum recommended response rate of 60% and hence the sample was adequate to provide findings that can be inference to the study population.

4.2 Socio-demographic characteristics of the respondents

The study key socio-demographic characteristics profiled for the study included; gender, marital status, source of livelihood, age, education level, number of people in the household and total land holdings.

4.2.1 Gender of the respondents

This was aimed at capturing a picture on the number of men and women involved in coffee production in the area.

Table 1: Distribution of respondents by gender

Category	Frequency	Percent
Male	179	47.6
Female	197	52.4
Total	**376**	**100.0**

Results show that, 52.4% of the respondents were female and 47.6% male. The high number of women compared to men is reflected on agricultural sector in Uganda which is largely dominated by women than men.

4.2.2 Age of the respondents

Respondent's age was necessary because it determines farmer's ownership of production resources, as well as influences production decisions, agricultural information seeking behavior and capacity to access credit services.

Table 2: Age of the respondents

Category	Frequency	Percent
15 below	34	9
16 - 30	90	23.9
31 – 45	178	47.3
46 and above	74	19.7
Total	**376**	**100.0**

Results show that majority (47.3%) of the respondents were aged 31 – 45, 23.9% were aged 16 - 30 years while 19.7% and 9% were aged above 46 and below 15 years respectively. Those aged 16 – 45 formed the biggest proportion of the respondents.

4.2.3 Marital status of the respondents

Marital status of respondents was considered because it is very critical in decision making and adoption of production technologies and management practices. Responses on marital status were as shown in the table 2 below;

Table 3: Distribution of respondents by marital status

Category	Frequency	Percent
Married	203	54.0
Not married	133	35.4
Others	40	10.6
Total	**376**	**100.0**

Table 2 above indicate that 54% of the respondents were married, 35.4% single while 10.6% comprised of those that were cohabiting, separated and widowed.

4.2.4 Education level of the respondents

Education level of the respondents was considered because it is very critical in technological adoption and use, production decision making and information seeking behavior of the farmers.

Table 4: Education level of the respondents

Category	Frequency	Percent
Not attended any formal education	34	9
Primary	56	14.9
Secondary	189	50.3
University	45	11.9
Others	52	13.9
Total	**376**	**100.0**

According to the findings in table 4 above, those with secondary education (50.3%) formed the biggest part of the study, followed by 14.9% with primary, 13.9% with tertiary education, 11.9% university, while 9% had never attended school.

4.2.5 Household size

Household size influences labour availability for coffee production and other related activities, Household members are the main source of labour for different coffee production activities in the study area.

Table 5: Household size

Category	Frequency	Percent
1 – 5	127	33.7
6 – 10	206	54.8
10 and above	43	11.4
Total	**376**	**100.0**

Results indicate that more than a half (54.8%) of the respondents were from a household of 6 – 10 members, 33.7% from a household of 1 – 5 members while 11.4% were from a household of 10 members and above.

4.2.6 Source of income

Household source of income was considered for the purposes of establishing the income levels which had an impact on level of adoption to agricultural production technologies and management practices.

Table 6: Sources of income

Category	Frequency	Percent
Farming	201	53.5
Salary	93	24.7
Business	43	11.4
Farming and Business	23	6.1
Farming and Salary	16	4.3
Total	**376**	**100.0**

According to the findings, more than a half (53.5%) of the respondents depended on agriculture for income, 24.7% relied on salary, 11.4% operated small scale business for income, 6.1% relied on both farming and business while 4.3 depended on both faring and salary.

4.2.7 Total size of land owned

Table 7: Total size of land owned

Category	Frequency	Percent
Below 1 acre	57	15.2
2 – 4 acres	127	33.8
5 – 6 acres	159	42.3
6 and above	33	8.7
Total	**376**	**100.0**

Results indicate that 42.3% of the respondents owned 5 – 6 acres of land, 33.8% 2 – 4 acres, 15.2% below an acre whereas 8.7% owned 6 acres and above. An average land distribution were of 5.3 acres.

4.3 Coffee production systems and management practices used by farmers

The results in Table 8 indicate that 54% of the respondents were growing Arabic coffee while 46% were growing Robusta coffee.

Table 8: Variety of coffee grown on farm

Variety	Frequency	Percent
Arabica coffee	203	54.0
Robusta coffee	173	46.0
Total	**376**	**100.0**

According to the results in the table 8, 75.8% of the respondents practiced intercropping, 24.2% practiced mono cropping (pure stand).

Table 9: Coffee production systems

Production system	Frequency	Percent
Intercropping	285	75.8
Mono cropping(pure stand)	91	24.2
Total	**376**	**100.0**

In terms of management practices applied, 23.7% of the respondents practiced weed control, 21.5% shading, 15.2% pruning, 14.1% fertilizer application, 12.2% pest and disease management, 6.6% water drainage management, 4.0% practiced transplanting while 2.7% seedbed management.

Table 10: Management practices applied in coffee production

Practice	**Frequency**	**Percent**
Weed control	89	23.7
Shading	81	21.5
Pruning	57	15.2
Fertilizer application	53	14.1
Pest and disease management	46	12.2
Water drainage management	25	6.6
Transplanting	15	4.0
Seedbed management	10	2.7
Total	**376**	**100.0**

4.4 Socio-economic factors affecting farmers use of recommended management practices for improved coffee productivity

Table 11: Parameter estimates for socio-economic challenges associated with the utilization of recommended practices for coffee production

	Challenges	Values	AOR	95% CI.	p-value
Model	Age bracket	15 below	1.290	0.370 - 4.499	0.690
		16 - 30	2.321	0.129 - 4.797	0.014
		31 – 45	0.991	(0.974 - 1.008)	0.294
		46 and above			
	Education	Never went to school	1.486	0.573 - 3.851	0.415
		Primary	0.749	0.263- 2.129	0.123
		Secondary	1.919	(0.870 - 3.970)	.002
		University	1.024	.952 - 3.101	0.529
		Others			
	Labour availability	Available	0.850	(0.757 - 0.954)	.005
		Not available			
	Farm size	Below 1 acre	0.786	0.334 - 1.306	0.341
		2 – 4 acres	1.950	0.761 - 2.496	0.133
		5 – 6 acres	1.930	(0.887 -2.976)	0.003
		6 and above			
	Experience	In years	1.104	(1.009 - 1.208)	0.031
	Gender	Male	1.676	(1.048 - 2.682)	0.031
		Female	.	.	.
	Religion	Catholic	0.364	(0.863 – 2.153)	0.183
		Protestant	1.009	(0.932 - 1.091)	0.435
		Muslim	0.156	(0.068 - 1.608)	0.864
		Others			
	Culture		0.736	(0.468 – 1.158)	0.185
	Access to extension	Yes	1.288	(0.609 - 2.720)	0.508
		No	.	.	.
	Slope of the farm		1.410	(0.460 - 4.324)	0.048
	Off-farm incomes	In shillings	1.488	(0.594 - 3.729)	0.397
	Income status	High	0.761	(0.366 - 1.581)	0.464
		Low			
	Access to credit	Have access	1.221	(0.539 - 2.763)	0.032
		Do not have			
	Plot ownership type	Rented	1.633	(0.291- 2.378)	0.049
		Inherited	.622	(0.306 - 1.266)	0.191
		Purchase	.	.	.

a. The reference category is: no.

b. This parameter is set to zero because it is redundant.

Table 11 shows a logistic regression output for the socio-economic factors affecting farmer's use of recommended management practices. Adjusted odd ratios were calculated, significant factors were interpreted at 95% confidence interval and 5% level of significance. Fourteen variables were hypothesized and among them, nine (9) factors remained significant and these included;

Age of the farmer [AOR = 2.321, p=0.014], Level of education of the household head [AOR = 1.919, p=0.002] , Lack of labour [AOR = 0.850, p=0.005], Farm size [AOR = 1.930, p=0.001] , farming experience [AOR = 1.104, p=0.031], Gender [AOR = 1.676, p=0.031], Slope of the land [AOR = 1.410, p=0.048], Un-accessibility to credit services [AOR = 1.221, p=0.032], Plot ownership type [AOR = 1.633, p=0.049].

4.5 Interventions for addressing the socio-economic impediments to the use of management practices for sustainable coffee production

Results in table 12 highlight respondent’s suggestions on the interventions for addressing the socio-economic impediments to the use of management practices.

35.1% of the respondents mentioned of community capacity building and developing the skills and knowledge of the farmers in different aspects of coffee management through training and education, 23.7% strengthening agricultural extension, 15.7% talked of credit extension, 13.6% changing land reforms to enable farmers have access to more productive land while 11.9% mentioned of encouraging farmers to form groups to ease to access to inputs and credit services.

Table 12: Interventions for addressing the socio-economic impediments to the use of management practices

Category	Frequency	Percent
Capacity building/ Skill and knowledge development	132	35.1
Strengthening agricultural extension	89	23.7
Credit extension	59	15.7
Land reform policies	51	13.6
Farmer group formation	45	11.9
Total	**376**	**100.0**

CHAPTER FIVE: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Discussion of Findings

5.1.1 Coffee production systems and management practices used by farmers

There were two coffee production systems used by the farmers in the study area namely; mono cropping (pure stand) and intercropping. Under intercropping system which is widely practiced (78.8%), coffee was planted with crops or trees also called agro-forestry systems. Coffee was grown with perennial crops like banana and annual crops like beans, soya bean and groundnuts to support household food security given the limited production space (land size) in the area and also grown with different types of trees to provide ecological benefits such as shading, breaking speeding winds, conserving the soils as well as recycling nutrients. Coffee farmers planted semi-permanent shade of leguminous shrubs such as calliandra, flamingia, tephrosia between every fourth row of coffee and around the edges of the plantation. Permanent shade trees such as *Albizzia spp* (migavu), *Ficus spp* (Mutuba, Mucusu, Ekitooma), *Cordiaafricana* were planted at a spacing of 15 by 15metres or 20 by 20metres.This study finding is comparable to findings by Hulme et al., (2012) who mentioned that trees incorporated in agro ecosystems provide a range of ecological advantages. Below ground, the roots of the trees penetrate the soil deeper than the roots of smaller plants which affects soil structure, nutrient recycling and soil moisture conditions. Some of the trees can also benefit the agro ecosystem by forming symbiotic relationships with *mycorhizza* which can increase nutrients uptake from the soil, and leguminous trees can contribute nitrogen to the system which they are part of. By absorbing nutrients from deep soil layer, trees can increase nutrient recycling and reduce the need of synthetic fertilizing.

Similarly, some respondents practiced mono cropping/Pure stand system and this involved growing of coffee as a single crop on one piece of farmland. This system was not widely practiced (24.2%) as compared to intercropping system (75.8%) because it requires large farm sizes to provide space for other resources like fuel/fire wood and food security, there is no nutrient re-cycling and also reduced household income. This study finding is in line with UCDA (2012) that argued while mono-culture may increase coffee yields, it can potentially reduce the food available to feed the household and also growing the same coffee crop year after year depletes valuable soil nutrients that plants rely on and hence deficiency must be compensated for by using increasing amounts of appropriate fertilizer. Mono culture is highly susceptible to pests and diseases, requires intensive use of chemicals to controls pests and diseases and weeds and limits optimum utilization of land and the resultant farm revenue.

Weed control was the most management practice in the area and from the respondents and the extension worker; most farmers use mechanical methods like hoeing, slashing because it is traditional and easy to practice and others use cultural methods like mulching and chemical control use of herbicides. In coffee, weeds cause several direct and/or indirect negative impacts, such as; reducing coffee bean/screen quality, reducing crop yield, increasing production costs, reducing irrigation efficiency, and serving as hosts and habitats for insect pests, disease-causing pathogens, nematodes, and rodents. This study finding is in line with Kandji and Verchot, (2014) who argued that weed control is important in coffee production to avoid competition for moisture, nutrients, space, sunlight, and to minimize the spread of pest and disease and if weeding is neglected, coffee yields will be depressed and poor quality will result. Weeds can directly hinder coffee growth by competing for available resources and, in some cases, by releasing allelopathic, or growth-suppressing, chemicals.

Respondents reported shade provision as a management practice and they use different types of trees in coffee plantations such as *Albizzia spp* (migavu), *Ficus spp* (Mutuba, Mucusu, Ekitooma), *Cordiaafricana* and planted at a spacing of 15 by 15metres or 20 by 20metres. These provide benefits such as shading, breaking speeding winds, conserving the soils as well as recycling nutrients. This study finding is comparable to findings by Hulme et al., (2012 who argued that above ground trees affect the solar radiation and creates a microclimate under its canopy, which can stabilize temperature conditions, which in turn increases humidity and limit evapotranspiration. Shade trees play a role in efficient utilization of nutrients by taking up leached nutrients that are outside reach of the coffee tree root zone and returning these nutrients to the top soil through litter fall and which also act as mulch.

Another management practice in coffee production in Kirugu and Kichwamba Sub-County was pruning. This was done by removing un necessary branches and un productive wood to eliminate competition for nutrients hence allowing the tree to produce good crop yields years after years. This was done using hands because most farmers cannot afford buying pruning tools. Pruning also creates conditions that are less favourable to pests and diseases infestation. This study finding concurs with MAAIF (2020) that recommended pruning as an essential task for maintaining strong and healthy coffee trees and creates well-structured, healthy trees that give good cherry yields but encouraged use of pruning tools like pruning saw and secateurs during pruning.

According to the results, respondents identified pests and disease control as a coffee management practice. The most common coffee pests included Black Coffee Twig Borer (BCTB), Coffee Berry Borer (CBB), Coffee Mealybug and common coffee diseases included Coffee Wilt Disease, Coffee Leaf Rust. Pests and diseases affect the health of the coffee plants which further leads into quality deterioration, quantity loss and eventually reduced economic returns to the farmer. Coffee farmers commonly use cultural methods like pruning, removal of diseased coffee trees and some use chemicals/pesticides to control coffee pests and diseases This study finding agrees with Batary et al., (2011) who argued that coffee pests and diseases can mainly be controlled by (i) chemical; (ii) cultural and (iii) biological. Cultural and agronomic practices have been the best approaches to deter development and/or spread of pests and diseases. Timely application of pruning systems, weeding, shade control, drainage and removing diseased trees and burning them on site and/or burying have been the important management practices.

Furthermore, Fertilizer application was another management practice reported by respondents in the area of study. The most commonly used type of fertilizers is inorganic like NPK which is accessed through local dealers. NPK is applied to increase plant height, root development, water use efficiency, bean weight, and highest efficiency. Despite being expensive in terms of purchase costs, farmers prefer inorganic fertilizers because of their accessibility compared to organic fertilizer. This study finding concurs with Sannen et al., (2014) who argues that coffee quantity produced per unit area improves when soils are managed for optimum fertility. He further argued that Fertilizer application can increase yields of Robusta coffee from the average current of 1 metric tonne up to 3 metric tonnes of Fair Average Quality per hectare per year. Nitrogen is lost during leaching and phosphate is lost through fixation. Therefore, unless these nutrients are replaced, the quality of the coffee beans will be affected. Also UCDA (2012) reported that in one of the major coffee producing countries, Vietnam, the success to increased coffee production and productivity from less than 2 million bags in 1991 to about 30 million bags in 2017/18 has been due to prioritizing the use of water, fertilizer and variety.

5.1.2 Socio-economic factors affecting farmers use of recommended management practices for improved coffee productivity

The study identified significant socio-economic factors affecting adoption of different recommended management practices for coffee production and performance in the study area. These included; shortage of labour, Education level of the household head, farm size, experience in coffee farming, gender, slope of the farm, un-accessibility of credit services, Age of the farmer and plot ownership type among the farmers.

Lack of labour was significant factor limiting farmer's use of recommended coffee management practices at 5% level. It was observed that households with limited labour had 0.8times less chances of using the practices compared to those with labour. Labour is an important constraint in adoption of new technologies particularly those technologies that are labor-intensive. Labour availability was measured as the proportion of household members who contribute to farm work. This study finding was in line with findings by Van Asten, et al., (2012) who stated that the proportion of household members available to provide labour positively influenced adoption of soil fertility management practices. The number of household members who provide farm labour is positively associated with probability of participating in soil fertility management practices.

Similarly, the level of education of the household head was significantly associated with use of coffee recommended management practices at 5% level. Educated household heads had 1.9 times more chances of using recommended coffee management practices than the un-educated. This is because higher education gives farmers the ability to perceive, interpret and respond to new information much faster than their counterparts with lower education hence educated farmers had more chances than the un-educated. These results were in consistent with Sannen et al., (2014) who found education to be positively related to adoption of soil and water conservation measures.

Furthermore, farm size had a significant influence on farmer's use of recommended coffee management practices at 5% level of significance. Farmers with small plots had 1.9 times less likely to use management practices compared to those with large plots. This was because with a large farm size of land, a farmer can still produce from different other crops even if a new practice did not perform well when applied to crops on a smaller portion of land on the farm. This study finding concurs with Mwaniki, (2014) who stated that farm size can positively influence adoption because farmers with large farm sizes of land can experiment new technologies on a portion of land without worrying about endangering the family food security. In addition, the benefits from large-scale adoption of new technologies are absolutely large for larger farms.

Experience of the farmer was also a significant factor associated with use of recommended coffee management practices in Kirugu and Kichwamba Sub Counties at 5% level of significance. It was observed that farmers with experience in farming in years were 1.1 times more likely to use the recommended management practices in coffee production. This is because longer farming experience implies accumulated farming knowledge and skill, which has contribution for adoption. Many studies supported this argument for example Kandji and Verchot, (2014) found the mean farming experience difference of adopters and the non-adopters is statistically significant

A positive and significant relationship was observed between gender and use of recommended coffee management practices at 5% level of significance. It was observed that men compared to women are 1.6 times more likely to use coffee management practices because males easily access resources especially land. This study finding concurs with Allan et al., (2015) who showed that, male-headed households in developing countries have a higher access to resources and information that give them greater capacity to adopt. Using binary logit to determine farmer participation in new technologies, results indicated that male-headed households had a higher probability of adopting than women due to their high likelihood of access to requisite resources and information.

Slope of the land had a significant relationship with farmer's decision to use recommended management practices at 5% level of significance. Farmers with coffee plantations located on a steep slope were1.4 times more likely to adopt management practices compared to those with plots located in gentle slopes. This is because steep slopes experience more erosion and run offs than gentle slopes and hence this increases the chances of adopting control mechanisms compared to gentle slopes. This finding is comparable to findings by Charles et al., (2013) who in their study, multinomial logit results showed that the likelihood of households choosing to practice conservation declined with the perceived slope of the farm. This reflected the fact that plots with steeper slopes are more prone to soil erosion which necessitates adoption of farming techniques.

Furthermore, lack of credit services was a significant challenge associated with use of coffee management practices for coffee production in the area of study at 5% level of significance. It was observed that farmers who did not have access to credit services were 1.2 times less likely to use the practices and vice vasa. Given the nature of the agriculture sector in the area, many financial institutions do not normally give out loans to farmers in fear of the risks associated. A few that are willing to give loans to farmers have complicated loan terms of which most farmers may not satisfy like security, payback period etc. This lack of credit therefore limits farmer's capacity to invest in practices and technology. This study finding agrees with Vandermeer et al., (2010) who argued Coffee management involves more use of inputs which have great cost implication. Credit is very much useful to purchase inputs such as improved seeds and other inputs. Hence, access to credit is expected to influence the effectiveness of coffee management practices positively on the dependent variables. MugaggaandBuyinza, (2013) also stated that Borrowing money is one of the most expensive ventures in Uganda with interest rates hardly going below 25% per annum while informal money lenders (such as VSLAs) charge exorbitant rates of not less than 10% per month.

Age of the farmer was a challenge associated with the use of coffee recommended management practices at 5% level of significance. Farmers of ages between 16-30 were 2.3 times more likely to up-take coffee recommended management practices than those with ages below 16 and above 30. This is because older farmers are rigid in adopting new technologies. Perhaps this is because of investing several years in particular practices, which makes them unwilling to risk by trying out completely new farming methods. This study finding agrees with Hundera et al., (2012) who argued that age is negatively associated with farmer participation in a new technology.

From the study, plot ownership type was a significant factor limiting farmer's use recommended management practices at 5% level of significance. It showed that farmers with rented plots were 1.6 times less likely to use practices than those who inherited or purchased own plot. This is because one to invest in long term management practices needs long period of access and use of land. However there was no observed difference in the use of practices between farmers who inherited and those that purchased own plot. This study finding concurs with Allan et al., (2015) who revealed that plot ownership is a proxy measure for assured land access and this has a positive impact on the decision to adopt conservation tillage methods. Ownership of land increases the assurance of future access to returns on investments.

In general, the earlier stated null hypothesis that there was no significant association between the nine (9) factors (Age of the household head, Education, Labour availability, Farm size, Experience, Gender, Slope of the farm, Un-accessibility of credit services and plot ownership type) and use recommended coffee management practices was rejected.

5.1.3 Policy Interventions for addressing the socio-economic impediments to the use of management practices for sustainable coffee production

A number of policy interventions for addressing the socio-economic impediments to the use of coffee management practices were suggested by respondent. 35.1% of the respondents suggested the need for community capacity building through training and education. Capacity building was recommended by respondents to develop skills and knowledge of the farmers in different aspects of coffee management. This can be achieved through periodical hands on trainings. Through hands on training, farmers can be in a better position to acquire the necessary skills and knowledge required to apply and sustain production management practices and technologies. This study finding is comparable to findings by Mugisha & Alobo, (2012) who revealed that building farmers' management and problem solving capacity requires joint learning through practical FFS work. This requires a shift from previous perceptions where farmers were seen mainly 'adopters' or 'rejecters'' of technologies but as providers of knowledge and improved practices. Many studies have shown the ability among farmers to innovate and develop their own solutions to problems through FFSs, there by being part of the innovation system rather than just recipients.

Furthermore; the respondent recommended the need to strengthen agricultural extension by government through additional budget allocation to recruit Assistant Agricultural Officers so that rural farmers can fully access the extension advisory services on coffee recommended management practices. For a long time, the Ugandan agricultural extension system has remained weak in terms of operations resulting from underfunding, extension to farmer ratio in the area of study is high (1:1500) and area of coverage for one extension worker Agricultural Officer (all Sub County) is big. As a result farmers in most remote rural settings are unable to access extension services. This study finding concurs with Mendez et al., (2010) who indicated that the role of extension is to educate the people to understand that they are an agent of change and are able to influence their communities by addressing their immediate problems through application of acquired technology. The process of extension education is one of working with people helping them by means of education to put to use useful knowledge that works for them.

The study indicated that 15.7% of the respondents recommended provision of credit extension and at low interest rate to farmers. Farmers need money to purchase inputs that are used in different activities on the farm such as mulches, herbicides, farm tools and hire labour to work on the farm. Lack of credit and high interest rates limits farmer's capacity to invest in good management practices. This study finding agrees with DeBeenhouwer et al., (2013) who stated that cash is essential in hiring labour and purchasing of farm inputs like seeds and animal manure. Mugagga and Buyinza (2013) argued that farmers pay cash for the raw materials in promoting a technology.

Revising Land reform policies was also another policy intervention recommended by respondents for addressing the socio-economic impediments to the use of coffee management practices in the area as indicated by 13.6% of the respondents. This was to prohibit more fragmentation and sharing of land among family members. Majority of the farmers hold their land under customary tenure and this tenure mostly involves fragmentation of land into small plots among family members hence less investment in new technologies of management practices. This is in agreement with Van Asten et al., (2012) who argued that larger farm sizes are better initiated for effectiveness of coffee management practices and farmer’s up-take of new technology. In addition Mwaniki, (2014) argued that the benefits from large-scale adoption of new technologies are absolutely large for larger farms.

The study findings further indicated that 11.9% of the respondents recommended the formation of farmer groups. Group formation promotes cohesion, knowledge sharing and farmers access to inputs and financial capita hence able to address some of the challenges that impair use of recommended practices in coffee production. This study finding is comparable to findings by Mendez et al., (2010) who argued that the impact of farmer group mobilization on technology adoption: One of the factors that encourage farmers to work in collaborative marketing groups (CMG) is the sense of security by members of the CGM in adopting new innovations. Individual farmers do not feel isolated in taking the risks associated with adopting new technologies, as the effect of adopting a particular innovation is felt by everyone in the group.

5.2 Conclusions

Basing on the results, the following conclusions were made;

1. Coffee in Kichwamba and Kirugu Sub counties was grown under two major production systems that is, intercropping and mono cropping (pure stand).
2. The major coffee management practices used included; seedbed management, transplanting, pruning, shading, fertilizer application, weeds control, pest and disease management and water drainage management.
3. The study further concluded that there are significant socio-economic factors affecting

adoption of different recommended management practices for coffee production and performance in the area such as; education level of the household head, shortage of labour, farm size, experience in coffee farming, gender, slope of the farm, un-accessibility of credit services, age of the farmer and plot ownership type.

4. These could be addressed through suggested policy interventions like; re-visiting land reform policies, credit extension, capacity building/skill and knowledge development, strengthening agricultural extension and encouraging group formation among farmers.

5.3 Recommendations

Basing on the study findings, the following recommendations were made in line with the study objectives.

- There is need for more education and training for farmers on the recommended practices since education influences farmers' decision to adopt technologies by enhancing their ability to understand and utilize the practice through overall managerial ability. This would help them acquire a specific level of knowledge need to use specific agricultural technologies. This was because a big number of farmer were partially educated which perhaps explained their luck of understanding on certain practices.
- Revisiting land policies is paramount if farmers in the area are to use recommended management technologies. Small sized land was one of the reasons farmers fail to use recommended practices, therefore increasing land size/area stopping land fragmentation and promote consolidation of land areas would mean that farmers have enough spaces/area to try new technologies/practices.
- Groups, associations and cooperative formation should be encouraged. These farmers

associations ease farmer's access to support services like inputs, extension and credit services.

- There is need to support farmers through credit services. This can be achieved through establishing village SACCOs/banks, and starting loan schemes for farmer's loans at low interest rate.
- Farmers need to be educated on the best coffee production system and management practices to boost coffee production.
- There is need for collaboration and cooperation among the small scale farmers and Non-governmental organizations to deal with the socio-economic factors limiting the use of recommended practices for coffee production.
- There is need for more capacity building and external support. This can be achieved through providing agricultural advisory services
- There is need to change the mindset and perceptions of the farmers towards the use of recommended practices. This can be achieved through organizing educational trainings at sub-county and village level.

5.5 Areas for further research

The study recommends for further research on other factors other than socio-economic factors such as institutional and environmental that influencing uptake of the recommended practices. In addition, further studies can be conducted to ascertain the effect of differing socio-demographic characteristics of coffee producing farmers on the uptake level of recommended coffee management practices.

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APPENDICES

Appendix I: Questionnaire for Farmers

Dear respondent

I am **Ahimbisibwe Jerome Ronalds,** a student of Bishop Stuart University carrying out a study titled "**The socio-economic factors influencing the uptake of coffee production recommended practices in Kichwamba and Kirugu sub-counties Rubirizi district**". This study is part of the requirements for my course and is for academic purposes only, the answers that you provide will be treated with utmost confidentiality, please co-operate by providing the correct information only.

Respondent Address

Name…...................... Telephone number…..................

Parish…............. Village…..............

Position in the household…......................

SECTION A: Demographic characteristics

1. **Gender:** 1. Male ( ) 2. Female ( )

2. **Age in years**…..................

3. Educational level in years…....................

4. **Marital status**

1. Never married ( ) 2. Married ( ) 3. Separated ( )

4. Divorced ( ) 5. Widowed ( ) 6. Cohabiting ( )

5. Occupation

1. Local council leader ( )
2. Farming ( )
3. Extension service provision ( )
4. Any other specify…...........

6. Household size…....................

7. Sources of income

1. Crop farming ( ) 2. Animal rearing ( ) 3. Employment ( ) 4. Others specify…......

8. If crop farming, rank four most important crop enterprises on your farm? Rank in order of priority.

1…......................

2. …........................

3. …........................

4. …........................

9. Total size of land owned in acres…...........

10. Mode of land acquisition

1. Purchase ( ) 2. Inherited ( ) 3. Rented ( ) 4. Others…........

SECTION B: Coffee production systems and management practices used by farmers

1. Do you grow coffee on your farm?

1. Yes ( ) 2. No ( )

2. If yes, what variety of coffee do you have on your farm?

1. Arabica coffee ( ) 2. Robusta coffee ( ) 3. Mixed ( ) 4. Others…..........

5. What is the size of land under coffee production…..............

6. Mode of cropping

1. crop rotation ( ) 2. Intercropping ( )

3. Mono cropping (pure stand) ( ) 4. Others …..............

7. How long have been growing…....................

8. What is the terrain of your coffee plantation?

a. Steep slope ( ) b. Gentle slope ( ) c. Flat land ( ) d. Others…

9. Do you experience soil erosion on your coffee farm?

1. Yes ( ) 2. No ( )

10. If yes, which form of erosion do you experience in your coffee farm?

1. Shit ( ) 2. Rill ( ) 3. Gulley ( ) 4. Others….....

11. Have you put any measures in place to control the erosion problem on your farm?

1. Yes ( ) 2. No ( )

12. If yes, what measures have you introduced?

…..

13. Apart from the soil erosion measures employed in 12 above, have you adopted any other practice(s) to ensure improved coffee productivity on your farm?

1. Yes ( ) 2. No ( )

14. If yes, what are some of these practices?

…...
.

15. What was your source of information on the practices in 14 above?

a. Extension agents ( ) b. Media (Radio & TV) ( ) c. Internet ( )

d. Fellow farmers ( ) e. Others (specify)…..........

16. How do you rate the effect of each practice on coffee productivity?

Practice	**More effective**	**Neutral**	**Less-effective**
1			
2			
3			
4			
5			
6			
7			

SECTION C: Socio-economic factors affecting farmers use of different recommended management practices in the management of coffee.

1. Could there be socio-economic impediments to farmer’s use of different recommended management practices in the management of coffee in this area?

1. Yes ( ) 2. No ( )

2. If yes, highlight?

a. Social-economic factors affecting farmers use of different recommended management practices in coffee

Socio-Economic Factors	
Age of the farmer	
Gender	
Level of education	
Income status	
Religion	
Culture	
Farm size	
Availability of Labour	
Experience	
Access to extension	
Off-farm incomes	
Un-accessibility of credit services	
Plot ownership type	
Others ……………….	

b. Other factors

....

SECTION D: Interventions for addressing socio-economic impediments to the use of management practices

1. Are there any interventions so far implemented to address the limiting factors for adopting coffee management practices?

1. Yes ( ) 2. No ( )

2. If yes, what are some of the interventions at community level?

....

3. What policies are in place to address the challenges of using coffee management practices?

....

4. A part from policies, what else has government done to promote sustainable coffee production in this area?

....

5. Any last remarks about the study?

....

Thank you

Appendix II: Interview Guide

Interview check list

1. What is the primary source of income for farmers in this area?
2. What are the major crops farmers grow in this area?
3. How long has coffee been grown in this area?
4. How do you categorize majority of coffee farmers in this area in terms of coffee production?
5. What are coffee farming systems practiced in this sub county?
6. What are major challenges in coffee production?
7. Are there good recommended management practices under coffee production that you know? Which ones?
8. What are socio-economic factors hindering the farmer's use of the recommended management practices in coffee production?
9. What are possible recommendations for promoting the farmers use of recommended management practices to increase coffee production?