INFLUENCE OF AGROFORESTRY AND DEMOGRAPHIC CHARACTERISTICS ON THE SUBJECTIVE WELLBEING OF HOUSEHOLDS PRACTICING AGROFORESTRY IN GASABO DISTRICT, RWANDA

Jean Luc Mutagoma

A Thesis Submitted in Partial Fulfilment of the Requirements for the Award of the Degree of Master of Science in Environment and Natural Resources Management in the Department of Environment and Natural Resources Management and the School of Science and Technology of Africa Nazarene University

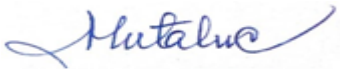
May 2022

DECLARATION

I declare that this document and the research that it describes are my original work and that they have not been presented to any other university for an academic award.

Jean Luc Mutagoma

(19m01dmev010)



May 30th, 2022

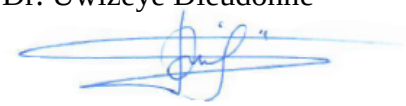
_____ _____

This research was conducted under our supervision and is submitted with our approval as university supervisors.

Dr. Mark Ndunda Mutinda

_____ _____

Dr. Uwizeye Dieudonné



May 30th, 2022

_____ _____

Africa Nazarene University

Nairobi, Kenya

DEDICATION

I dedicate this work to my wife Dr. Uwizera Janvière and our sons Mutagoma Higa Delight and Mutagoma Esa Hansel for their everyday support and encouragement during my studies.

ACKNOWLEDGEMENT

First and foremost, I thank the almighty God for his protection, grace, and blessings upon me during this academic stay.

My deep and sincere gratitude goes to my research supervisors, Dr. Mark Ndunda Mutinda and Dr. Dieudonné Uwizeye for their continued support and assistance throughout the elaboration of this thesis. I would also like to appreciate Dr. Sharon M. Jones, Head of the Department of Environment and Natural Resources Management for her invaluable guidance during this research work.

I am extending my heartfelt thanks to the members of Zamuka cooperative for accepting to participate in this research and for their assistance to the research team during the data collection process. Lastly, I wish to thank my family for their patience, encouragement, and support during my study

.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Agroforestry coverage is low within households because farmers are less motivated to plant more agroforestry trees on their farms. This study aimed at assessing the influence of agroforestry and demographic characteristics on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda. Independent variables investigated were household demographic characteristics, agroforestry practices applied, agroforestry inputs used, agroforestry land size, as well as agroforestry income, and the household subjective wellbeing as the dependent variable. Government policy remittances were studied as intervening variables. Grounded on a review of literature on agroforestry and social-ecological system theory, a survey was conducted on a population of 910 households and a sample of 270 households practicing agroforestry in Zamuka Cooperative. The reliability of the survey questionnaire was tested before data collection. The selection of respondents followed a stratified random sampling procedure. The collected data were analysed using descriptive and inferential statistical tools of the Statistical Package for Social Science (SPSS Version 20). The wellbeing of household demographic characteristics was very high (M = 6.99 and SD = 1.507) on a scale of 1 to 10. Except for the sex of the household head, other demographic characteristics (age, household size, and formal education level) showed no significant positive influence on the subjective wellbeing of households. The regression analysis exhibited that agroforestry practices applied have a significant positive influence on the subjective wellbeing of households ($ß$ = 0.504, t = 9.554, p = 0.001), as well as agroforestry inputs used ($ß$ = 0.418, t = 7.52, p = 0.001), agroforestry land size ($ß$ = 0.196, t = 3.279, p = 0.001), and agroforestry income ($ß$ = 0.485, t = 9.067, p = 0.001). The study concluded that agroforestry has a significant positive influence on the subjective wellbeing of households. Therefore, the study recommends that policymakers, development partners, and farmers to consider the significant positive influence of the sex of the household head; to increase the number of agroforestry practices applied, to increase the number of agroforestry inputs used, to increase the number of agroforestry land size, and to increase the number of agroforestry income for their influence on the subjective wellbeing of households practicing agroforestry.

DEFINITION OF TERMS

Agroforestry: Agroforestry is defined simply as "agriculture with trees" or more comprehensively as "the practice and science at the interface of, and interactions between agriculture and forestry, involving farmers, livestock, trees, and forests at multiple scales" (World Agroforestry, 2017).

Smallholder farmers: Farmers practicing agriculture on less than a hectare of land.

World Agroforestry Center: The former "International Center for Research in Agroforestry (ICRAF)", an international institute headquartered in Nairobi, Kenya, and founded in 1978.

Vi Agroforestry: A Swedish Non-Governmental Organisation promoting Agroforestry.

Subjective wellbeing: The name that scientists give to happiness-thinking and feeling that our lives are going very well (Diener, 2022).

Subjective wellbeing scales: Self-report surveys or questionnaires in which participants indicate their levels of subjective wellbeing, by responding to items with a number that indicates how well off they feel (Diener, 2022).

LIST OF ACRONYMS AND ABBREVIATIONS

BNR: Bank Nationale du Rwanda

FAO: Food and Agriculture Organisation

GDP: Gross Domestic Product

ICRAF: International Council for Research in Agroforestry (World Agroforestry Centre)

INDC: Intended National Development Contribution

MINAGRI: Ministry of Agriculture

MoE: Ministry of Environment

NISR: National Institute of Statistics of Rwanda

NST1: Rwanda National Strategy for Transformation 2017-2024

NTSC: National Tree Seed Centres

RAB: Rwanda Agriculture Board

REMA: Rwanda Environment Management Authority

RWFA: Rwanda Water and Forest Authority

UNFCCC: United Nations Framework Convention for Climate Change

CHAPTER ONE

INTRODUCTION

Introduction

Agroforestry is expected to improve the wellbeing of households while also combating climate change in different corners of the globe. Objectively, this chapter iterates the views of different scholars on the importance of agroforestry, and the following sections are included in this chapter: Introduction; Background of the study; Statement of the problem; Purpose of the study; Objectives of the study; Research questions Significance of the study; Scope of the study; Delimitation; Limitations; Assumptions; Theoretical framework; and Conceptual framework of the study.

Background of the Study

Agroforestry coverage is low because farmers are less motivated to plant more agroforestry trees on their farms **(**Ndayambaje et al., 2012). There is also a lack of empirical evidence of the influence of agroforestry on the subjective wellbeing of households. The objective of this study was to assess the influence of agroforestry and demographic characteristics on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda.

The Government of Rwanda puts tremendous efforts into planting new agroforestry trees every rainy season, but very few subsist their first year. The Government of Rwanda is actively promoting agroforestry to be a major source of energy as it endeavours to provide affordable electricity for all (REMA, 2018).

A study by Bastien (2018) proved that agroforestry can impact the wellbeing of smallholder farmers' households. A similar study showed that trees grown on farms impact the livelihood of households across Africa (Daniel et al., 2020).

Agroforestry is the practice and science of interactions of trees, crops, and livestock on a farm to meet basic needs such as food, fodder, medicine, timber, fuel, and market commodities while sustaining the environment at multiple scales (Coulibaly et al.,2017; Garrity, 2004). Also, Agroforestry is defined simply as "agriculture with trees" or more comprehensively as "the practice and science of the interface and interactions between agriculture and forestry, involving farmers, livestock, trees, and forests at multiple scales" (World Agroforestry, 2017).

Scientists worldwide believe that agroecology mitigates environmental degradation and sustains the health and economic situation of farmers (Bastien, 2018). Agroforestry is important as it shapes the living standards of farmers by providing food, and fuel, and improving the fertility of agricultural land (Adebe et al., 2019). While the importance of agroforestry is widely documented, the casual impacts of various agroforestry practices on farmers' wellbeing have hardly been analyzed (Jeanne et al., 2017; Bastien, 2018). In Nepal, agroforestry systems support the livelihood of a huge number of rural farmers (Pandit et al., 2014), and the integration of trees on farms impacts the livelihood of households across Africa (Daniel et al., 2020). The agroforestry ecosystem feeds around 560 million people around the world and takes up to 10% of global tree cover, which comprises 31% of all human-inhabited farmland (Zomer et al., 2009).

Currently, agroforestry is recognized by the international community as a reliable solution to constraining effects of environmental degradation associated with soil erosion, a decline in soil fertility, biodiversity depletion, and climate change (Ndayambaje et al., 2012). Development partners promote agroforestry as a potential strategy to help farmers reduce their exposure to the negative effects of climate change (Tanis & Henry, 2012).

In Rwanda, agroforestry is promoted to sustain the agricultural sector that currently occupies 77% of the country's area, feeds 90%, and employs 80% of the population (FAO, 2020). According to NISR (2020), to Rwanda's economy, agriculture contributes 26% of the Gross Domestic Product (GDP). Agroforestry, as a means to achieve an inclusive sustainable agricultural and environmental development, has been included in Rwanda's sustainable development strategies especially the Forest Sector Strategic Plan 2017-2021 and the National Strategy for Transformation (NST1) 2017-2024 with the target to double the agroforestry coverage from 6% to 12% by 2024 (Bernard et al., 2019). The Intended Nationally Determined Contribution (INDC) submitted to the United Nations Framework Convention for Climate Change (UNFCCC) in 2015 by the Government of Rwanda, expects to have a 100% of all farms practicing agroforestry by 2030 (FAO, 2020).

In a country with an annual population growth rate estimated at 2.4% per year (NISR, 2018), the pressure exerted on forests in Rwanda is likely to increase in the future. Presently, trees on farms are planted for increasing diversified productivity and reducing pressure on forests, of which deforestation was 7% in 2005 (FAO, 2005). This study,

therefore, seeks to assess the influence of agroforestry and demographic characteristics on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda. The findings of this study contribute to the implementation of the National Agroforestry Policy, its tailored strategies, and its programmes. Recommendations made by this study will expand the knowledge of policymakers, extension institutions, stakeholders, and farmers on the influence of agroforestry and demographic characteristics on the subjective wellbeing of households practicing agroforestry.

Statement of the Problem

Agroforestry extension programmes have not satisfactorily succeeded to increase agroforestry coverage because of the dearth of evidence on the link between agroforestry, demographic characteristics, and subjective wellbeing of households that would support awareness campaigns (Ndayambaje et al., 2012). This situation impedes Rwanda's sustainable development plans and strategies that aim at doubling agroforestry cover from 6% to 12% by 2024 (Bernard et al., 2019), and having 100% of all farms implementing agroforestry by 2030 (FAO, 2020). To that end, the Government of Rwanda makes huge efforts every year to increase agroforestry coverage within households' farms through tree planting campaigns, however very view planted trees survive their first year. For instance, for the 2018/2019 tree planting season, the Government of Rwanda targeted to plant a total of 225,440 fruit trees in 38,119 hectares of agroforestry land. In 2018, The Rwanda Water and Forest Authority (RWFA) targeted to plant 7,623,800 agroforestry tree seedlings, and 670 hectares of degraded forests rehabilitated countrywide (RWFA, 2018). During the 2019/2020 tree planting season, Rwanda planted a total of 13,241 Ha of land with an estimated 2,648,200 agroforestry tree seedlings and 428,785 fruit trees. The same year, the

Ministry of Environment of Rwanda achieved a forest cover of 33, 961 Ha with an afforestation rate of 20.7% (MoE, 2019).

Despite all of these enormous investments to increase agroforestry coverage within farmers' households, agroforestry uptake is still low mainly because farmers remain lowly motivated. To that end, it was valuable to empirically assess the influence of agroforestry and demographic characteristics on the subjective wellbeing of households practicing agroforestry, as a means to inform policymakers, extension institutions, and stakeholders with an interest in promoting agroforestry, and to contribute to increased agroforestry adoption within households to improve their subjective wellbeing.

Purpose of the Study

The purpose of this study was to empirically provide factual evidence on the influence of agroforestry and demographic characteristics on the subjective wellbeing of households practicing agroforestry. This would enhance plans, programmes, and strategies of policy-makers, extension agents, and stakeholders to increase agroforestry coverage within farmers' lands as a means to contribute to the subjective wellbeing of households.

Objective of the Study

1.5.1 Broad Objective

To assess the influence of agroforestry and demographic characteristics on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda.

1.5.2 Specific Objectives

(i) To determine the influence of household demographic characteristics on the subjective wellbeing of households practicing agroforestry in Gasabo District, Rwanda;

(ii) To investigate the influence of agroforestry practices applied on the subjective wellbeing of households practicing agroforestry in Gasabo District, Rwanda;

(iii) To examine the influence of agroforestry inputs used on the subjective wellbeing of households practicing agroforestry in Gasabo District, Rwanda;

(iv) To study the influence of agroforestry land size on the subjective wellbeing of households practicing agroforestry in Gasabo District, Rwanda;

(v) To assess the influence of agroforestry income on the subjective wellbeing of households practicing agroforestry in Gasabo District, Rwanda.

Research Questions

To assess the influence of agroforestry and demographic characteristics on the subjective wellbeing of households practicing agroforestry, this study was guided by the following questions:

(i) What is the influence of demographic characteristics on the subjective wellbeing of households practicing agroforestry in Gasabo District, Rwanda?

(ii) What is the influence of agroforestry practices on the subjective wellbeing of households practicing agroforestry in Gasabo District, Rwanda?

(iii) What is the influence of agroforestry inputs used on the subjective wellbeing of households practicing agroforestry in Gasabo District, Rwanda?

(iv) What is the influence of agroforestry land size on the subjective wellbeing of households practicing agroforestry in Gasabo District, Rwanda?

(v) What is the influence of agroforestry income on the subjective wellbeing of households practicing agroforestry in Gasabo District, Rwanda?

Significance of the Study

This study intended to be beneficial to three categories of people: The first category included governmental institutions who are mainly policy-makers, and extension agents in the field of agroforestry and household wellbeing. The findings of this study contribute to the work of policymakers and help extension agents to channel their message with facts.

The second category of people of interest in this study combined all stakeholders and development partners who work on promoting agroforestry as a means to alleviate poverty and fight environmental degradation and climate change. The third and last category included all farmers in various agriculture value chains. This study is of great and direct importance to agroforestry practitioners whose farm productivity increase will positively impact their household wellbeing. Locally, this study is very useful to the community as it is aligned with the national development plans and strategies. Globally, this study contributes indirectly to the adaptation and mitigation of global cross-cutting issues like climate change as it contributes to carbon sequestration through increased agroforestry tree cover.

The adoption of agroforestry and increase in agroforestry coverage is associated with the information shared between policymakers, extension agents, stakeholders, development

partners, and farmers. For this matter, the provision of evidence-based and accurate information is of paramount importance as long as the success of agroforestry scale-up is concerned. It was very important to assess the influence of agroforestry and demographic characteristics on the subjective wellbeing of households practicing agroforestry, to inform policy-makers, stakeholders, and farmers with evidence hence, leading to the increased area under agroforestry among farmers.

Development partners will benefit from the results of this study as the information from the ground will shape the areas to consider in their future development goals. This study is highly useful to farmers, as its results will remove confusion and barriers to the influence of agroforestry and demographic characteristics on their household's subjective wellbeing. This study was conducted to provide evidence-based information from the ground that would benefit farmers, policy-makers, extension agents, and stakeholders in agroforestry. Moreover, there is a perpetual huge loss of financial resources invested in promoting agroforestry that needs the value for money through convincing farmers of the influence of agroforestry and demographic characteristics on their subjective wellbeing.

Scope of the Study

The scope of this study is to assess the influence of agroforestry and demographic characteristics on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda. Gasabo is the most rural district of Kigali city, Rwanda, whose main economic activity is Agriculture. The target population is 910 farmers who are beneficiaries of the "Market-oriented Agroforestry for Livelihood Improvement in Zamuka".

This project was implemented by Zamuka cooperative under the support of Vi Agroforestry, a non-governmental organisation promoting Agroforestry in Gasabo district since 2008. Zamuka cooperative has been chosen as the target population for apart from operating in different corners of Gasabo district, its members received the package of training on agroforestry and various farm inputs to improve their farming businesses using the agroforestry.

Delimitation of the Study

Even if it was possible to assess other parameters that are indirectly related to agroforestry practices such as the type of tree species, such parameters seemed to have less importance in terms of the context of the study. The type of species adopted by farmers within the area of study was not investigated. This was because farmers used tree species that worked better for their type of crops and farming business preferences. Moreover, technicians from the Ministry of Agriculture (MINAGRI), Ministry of Environment (MoE), Rwanda Agriculture Board (RAB), and Rwanda Water and Forestry Authority (RWFA) in charge of natural resources and agriculture publish a list of agroforestry tree species that are specific to every agro-ecological zone.

Limitation of the Study

The local language was a limitation in this study. Since this was a survey in which respondents would answer all questions in the survey questionnaire, the local language was a limiting factor because respondents were smallholder farmers who do not speak English. To mitigate this limitation, research assistants acted as translators to ensure farmers can respond to all questions in the survey questionnaire.

Assumptions of the Study

To carry out this study, we assumed that all respondents would be available, and willing to answer all the questions in the questionnaire.

Theoretical Framework

Agroforestry, being the application of agroecology, aligns with Social-Ecological System (SES) theory and the socio-ecological system model developed by Urie Bronfenbrenner in the 1980s. The SES theory is built on the interactions between socio-economic systems and natural systems (Petrosillo et al., 2015). It recognizes the importance of considering people as part of an ecosystem rather than the opposite (Berkes & Folke, 1998).

Perez-Soba and Dwyer (2016) defined the SES theory as a coherent system of biophysical and social factors that regularly interact in a resilient, sustainable manner, hierarchically linked at different organizational scales. Berkes and Folke (1998) illustrated that the drivers of change result from interactions of people in and with the ecosystem, see Figure 1.1.

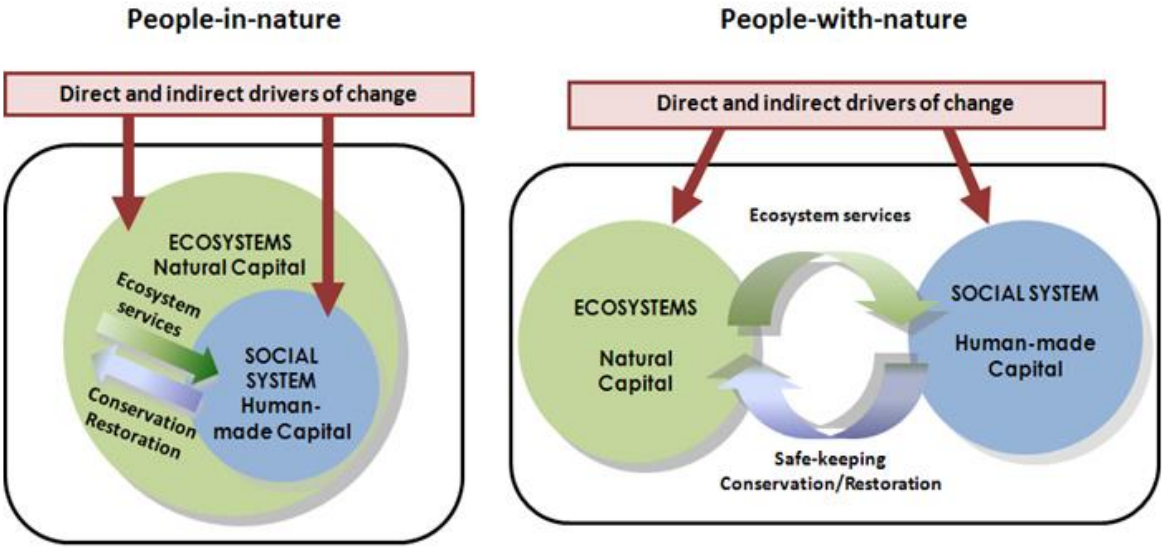


Figure 1.1 The Social-Ecological System Concept
Source: Berkes and Folke, 1998

The SES interactions operate at different levels of the community. At each level, the ecological component provides goods and services whereas the societal component intervenes with the human capital, regulatory and structural aspects.

In the context of this study, the interaction of the agroforestry ecosystem and members of households generates goods and services that influence their subjective wellbeing. Sustainable market-led agroforestry influencing household wellbeing was conceptualized as a function of five different and linked variables namely (i) household demographic characteristics; (ii) agroforestry practices applied; (iii) agroforestry inputs used; (iv) agroforestry land size, and (v) income made of selling and utilizing agroforestry products. The intervening variables in these interactions were government remittances that farmers received to develop their agroforestry farming enterprise.

Conceptual Framework

This study aimed at assessing the influence of agroforestry and demographic characteristics on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda. Explanation of the variables contained in the conceptual framework are detailed as follows:

i. Household Demographic Characteristics

This variable was related to the characteristics of respondents within households namely: age of the household head, sex of the household head, education level of the household head, and the household size.

ii. Agroforestry Practices Applied

Agroforestry practices applied are all types of agroforestry practices that a household applies on its farm. In the context of this study, agroforestry practices applied can be intercropping, alley cropping, scattered trees on the farm, contour hedgerows, fodder banks, home gardens, shelterbelts, windbreaks, and woodlots among others.

iii. Agroforestry Inputs Used

This variable was about the type, and quantity of inputs that a household used on its farm. They are mainly organic fertilizer, certified seeds, improved livestock breeds, tree seeds, and seedlings in addition to pesticides.

iv. Agroforestry Land Size

In the context of the conceptual framework for this study, agroforestry land size means the total area of farmland on which a household practices agroforestry. It was estimated in Hectares.

v. Agroforestry Income

In this study, agroforestry income means all kinds of income a household gained from selling or utilizing agroforestry products from its agroforestry farm. This income is obtained from selling mainly crops, livestock, fodder for livestock, timber, poles, and other products deriving from agroforestry farms.

vi. Household Subjective Wellbeing

The subjective wellbeing of the households is the dependent variable in this study. Subjective wellbeing is defined as the level to which a person believes her life is going well (Nima et al., 2020). In the context of this study, the household subjective wellbeing was measured in consideration of its indicators namely standard of living, health status, personal relationships, personal safety, community connectedness, quality of the environment, spiritual/religiosity, emotions and affiliations, and future security (Sirgy et al.,2006).

The standard of living is generally understood as the level of wealth, and services available to someone. Health status is defined as an individual level of wellness and illness.

A personal relationship is the ability of a person to connect and associate with other people. Personal safety is understood as recognition and avoidance of possible harmful situations or persons in your surroundings.

Community connectedness is one's perception and ability to socially connect with others through support and assistance (Bernat & Resnick, 2009; Debra et al., 2007). The quality of the environment is one of the indicators of subjective wellbeing. Quality of environment means the conditions of the environment in which people live, including air and water pollution, housing, and political conditions (Michael, 2003).

Religiosity is belonging to a given belief and it includes an aspect of experiential, ritualistic, ideological, intellectual, consequential, creedal, communal, doctrinal, moral, and cultural dimensions (Holdcroft, 2006). Emotions and affiliations reflect the subjective wellbeing of households. Affiliation is the state of being closely connected to someone or a social group while emotions are biological states and mental experiences generated by a high intensity of pleasure or displeasure (Cabanac, 2002).

Future security is a good indicator of subjective wellbeing as it refers to protection from harm and provision of the requirements for physical, emotional, economic, and social welfare (Elaine, 2013). Figure 1.2 is a conceptual framework that shows the relationship between the influence of household demographic characteristics, agroforestry practices applied, agroforestry inputs used, agroforestry land size, and agroforestry income on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda

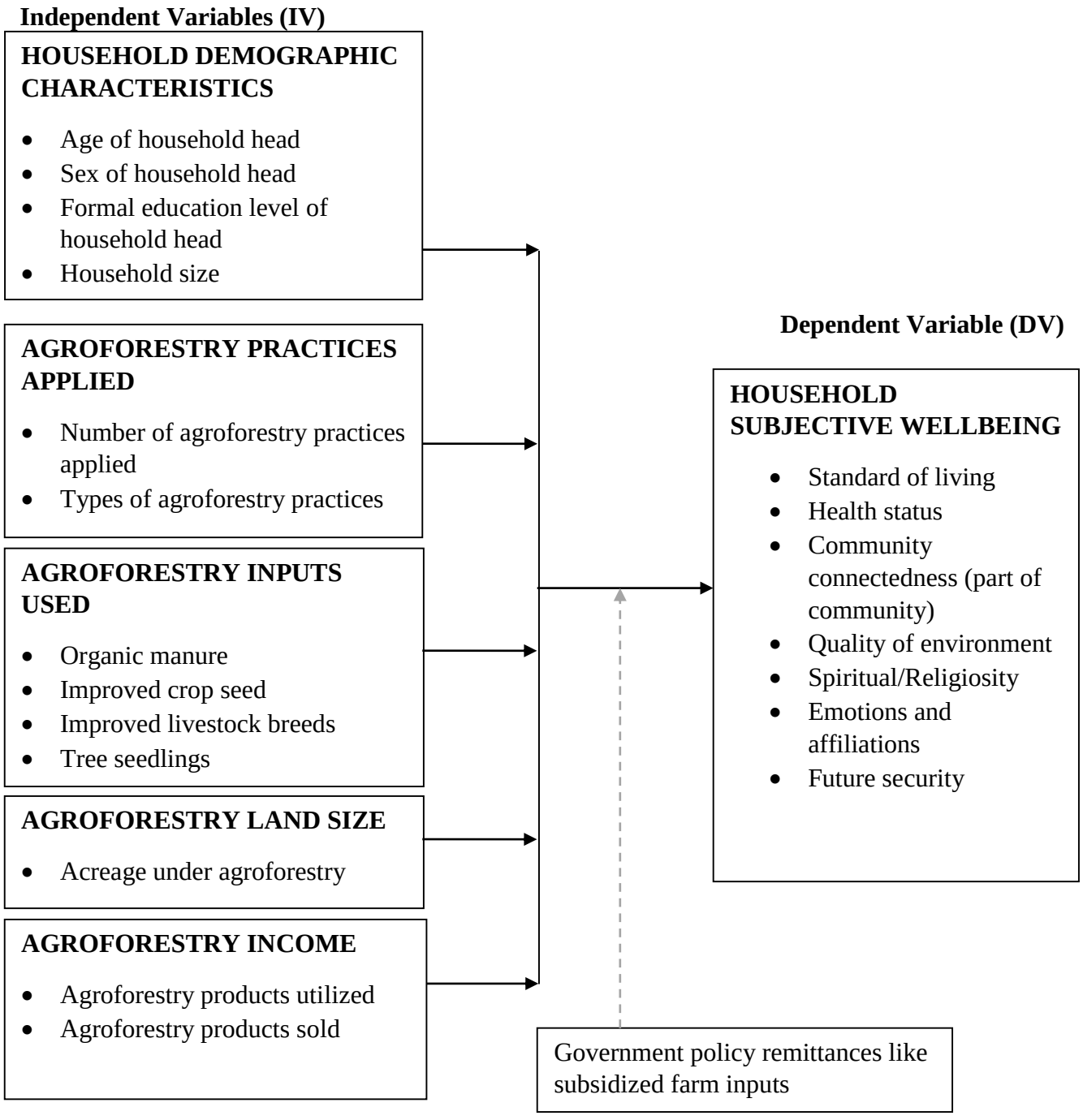


Figure 1.2 Conceptual Framework Showing the Relationship between Agroforestry, Demographic Characteristics and the Subjective Wellbeing of Households

The independent and dependent variables were conceptualized in the following manner: There is a relationship between the household demographic characteristics and the subjective wellbeing of households. The age of the head of the household affects decisions made towards agroforestry, therefore, influencing the subjective wellbeing of households. Also, the sex of the household head matters in this study. In the context of Rwanda where many households were left headed by women after the tragic 1994 Tutsi genocide, it was vital to consider the influence of male- and female-headed households on their subjective wellbeing. The level of education of the household head determines the decision-making, and the know-how related to the success of agroforestry, hence, influencing the subjective wellbeing of households. The household size is also linked to the provision of labor and the demand for agroforestry income, hence, influencing the subjective wellbeing of households.

Another independent variable linked to the subjective wellbeing of households in this study was the agroforestry practices applied. The type and number of agroforestry practices a household apply on its farm determine the quantity of the produce and income gained for that particular household, hence affecting its subjective wellbeing. By investigating the type and number of agroforestry practices a household applies on his/her farm, we were able to understand their influence on the subjective wellbeing of households. Agroforestry inputs used by a household was another independent variable in this study. The type and number of inputs applied by a household on its agroforestry farm, directly affect the output and income obtained from that unique agroforestry farm.

Studying the type and number of agroforestry inputs enabled us to assess the way those inputs influenced the subjective wellbeing of households. The influence of agroforestry land size on the subjective wellbeing of households was another point of interest in this study. The area under agroforestry for a given household determines the produce and income obtained by that household, hence its influence on the subjective wellbeing of that particular household.

Lastly, the type and quantity of agroforestry products a household harvests either for home use or selling determine its income, hence its influence on the subjective wellbeing of that household. In this study, agroforestry income was investigated to understand its influence on the subjective wellbeing of households.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Although several studies on agroforestry have been conducted, its influence on the subjective wellbeing of households has not been often considered. All sections in this chapter cover the reviews and studies related to the influence of agroforestry on the subjective wellbeing of households. Moreover, this chapter entails what other reviews and studies have said on the five independent variables for this study namely: (i) household demographic characteristics; (ii) agroforestry practices; (iii) agroforestry farm inputs; (iv) agroforestry land size and; (v) agroforestry income, all regarding the subjective wellbeing of households.

2.2 Subjective Wellbeing of Households

Wellbeing should not be confused with the concept of standard of living, which is primarily based on income considered as GDP per capita, in place of indicators of quality life which include physical and mental health, education, recreation, and leisure time, among others (Anheir and Stares, 2002). The literature on subjective wellbeing (SWB) is reviewed in three areas: measurement, causal factors, and theory (Diener, 2009). According to Diener, the SWB is concerned with how and why people experience their lives in positive ways, including both cognitive judgments and affective reactions. As such, the latter is interested in understanding happiness, satisfaction, morale, and positive affect. According to Diener (2009), wellbeing is defined as a normative concept that embraces external criteria such as virtue or holiness. This definition is eudaemonic as it focuses on possessing some desirable

qualities. However, Bianca et al (2009) defined wellbeing as the satisfaction and reliability of standards that determine the perception of a good life.

2.2.1 Measurement of Subjective Wellbeing

Social scientists made several suggestions on how SWB should be measured and factors that must be considered (Richard, 2010; Diener, 2009; Diener & Tov, 2012). For instance, measuring SWB considers emotional, psychological, and social dimensions (Diener, 2009). Measuring subjective wellbeing should rely on information from both online and recall measures to avoid discrepancies among data from these measures and should also focus on broad, and narrow measures as a means of reducing errors (Diener & Tov, 2012). Diener (2009) argues that measuring subjective wellbeing entails affective and cognitive measurements where affective wellbeing reflects the evaluation of conditions of individuals' lives while cognitive deals with scaling conditions of individuals' lives from dissatisfied to satisfied.

2.2.2 Factors Influencing Subjective Wellbeing

Socioeconomic characteristics are among the factors that influence subjective wellbeing (Kenneth et al., 2010). Age and sex have been identified by Park and Joshanloo (2019) as factors that influence subjective wellbeing in South Korea. However, factors influencing SWB vary according to categories of people in different locations. Similarly, it was found that an increased level of income effectively increases subjective wellbeing in developing countries (Naznin et al., 2015; Jeffrey & Douglas, 2002).

Although income adds to the SWB, it doesn't always guarantee it (Diener, 2022). In the same way, personality is among factors that strongly affect subjective wellbeing mainly because temperament influences the feelings of people and their way of evaluating and appreciating lives (Lucas & Diener, 2009; Diener, 2022).

2.3 Household Demographic Characteristics

Standard Household demographic characteristics such as age, sex of household head, education level, and household size in terms of family members, affect the adoption of agroforestry (Adebe et al., 2019). Demographic variables indicative of the household life cycle play a significant effect on land use practices (Stephen, 2001). Household demographic characteristics mainly age and sex composition affect land use and land cover change (De Sheribinin et al., 2007).

2.3.1 Age

In Malaysia, research has shown that subjective wellbeing decreases with age, especially for females (Park & Joshanloo, 2019; Geeta & Knight, 2007). Kenneth et al (2010) also found that age determines labor subdivision within members of households. For instance, while young children divert household labor resources from agriculture, older children contribute to the farm resources such as firewood, game, and water (De Sheribinin et al., 2007), therefore, contributing to the increased subjective wellbeing of households.

2.3.2 Sex

Although they are not at the same level, composite socioeconomic status, occupational status, and income are less strongly related to subjective wellbeing.

Males have slightly higher subjective wellbeing than females (Haring et al., 1984). However, a study conducted by Hughes and Waite (2002) contrasted the expectation of many that subjective wellbeing and negative health effects vary with gender. In the context of Rwanda, where after the tragic 1994 Tutsi genocide, many households were left headed by women, it is vital to consider the influence of male- and female-headed households, and agroforestry on the subjective wellbeing of households.

2.3.3 Formal Education Level

Among household characteristics affecting its subjective wellbeing is education level (Jeffrey & Douglas, 2002; Geeta & Knight, 2007). Education is believed to bring more expectations in life such as better jobs, beneficial networks, and higher esteem in the society, therefore it is positively correlated to subjective wellbeing (Kristoffersen, 2018). Education, innovation, and creativity were found by Dolan and Metcalfe (2012) to influence positively the subjective wellbeing of people, where for instance 20% increase in life satisfaction was associated with the impact of having a degree, and a 30% increase in happiness was equivalent to having a degree.

2.3.4 Household Size

The household number brings important social ties which link individuals to others and social structures (Hughes & Waite, 2002). However, family relations were found invariable in quality that to a certain extent, they tended to negatively affect the subjective wellbeing of households (Antonucci & Akiyama, 1995). Contrary to what many could expect, in rural areas, household number manifests a positive effect in enhancing household subjective

wellbeing, resulting in increased farm production through the availability of enough labor capital from household members (Naznin et al., 2015).

2.4 Agroforestry Practices

Common agroforestry practices in Rwanda are boundary plantings, contour hedgerows, home gardens, scattered trees on the farm, micro woodlots, intercropping, alley cropping, and fodder banks among others. Benefits from agroforestry practices are mainly fodder for livestock feeds, fruits, fuelwood, charcoal, timber, stakes for climbing crops, windbreak for crops like bananas, soil conservation, and erosion control, soil fertility improvement, and construction materials (Adebe et al., 2019). Agroforestry practices are considered one of the sustainable means to adapt to the effects of climate change (Ojedokun et al., 2020), therefore contributing to the wellbeing of households. Ewel (1999) illustrated that agroforestry practices make farmers happier as they acquire intensive knowledge, and creativity to adapt to specific conditions of their systems of production.

Research conducted by Kiyani and his colleagues (2017) in Nyamagabe District, Rwanda showed that agroforestry contributes to an increase in the income of farmers by improving soil fertility, reducing deforestation, and conserving soil and water. According to Bucagu et al (2013), uptake and management of agroforestry technologies differ among farms in Rwanda and need to be documented as a basis for shaping future research and development programs.

2.5 Agroforestry Inputs

Agroforestry inputs play a big and irreplaceable role in determining the quality and quantity of agroforestry produce which directly affects the income, and hence the wellbeing of households. Common agroforestry inputs known to farmers are mainly tree seeds, fruit seeds, organic manure, livestock breeds, and improved seeds for crops. From the 1980s up to the 1990s, agroforestry seeds were supplied by National Tree Seed Centers (NTSC) established in 21 African countries under the support of European countries and Canada (Graudal & Lillesø, 2007). Later on, the role of NTSC in supplying agroforestry seeds to farmers was taken by Non-Governmental Organisations that currently share the market demand with private investors (Lillesø et al., 2011).

2.6 Agroforestry Land Size

Despite the small farm sizes of smallholders in Rwanda, farmers appropriately integrate trees, and shrubs on their small farms (Ndayambaje & Mohren, 2011). According to NISR (2018), Rwanda has 1,592,604 Ha of agricultural land suitable for agroforestry. A field survey conducted by the COWI consortium with the support of the European Union in 2018 on agroforestry coverage in Rwanda showed that the area under agroforestry is above 150,000 Ha nationwide with 15.5% of the land with agroforestry tree density greater than 200 trees/Ha. In Gasabo, the average land size for farmers is 0.5 Ha and it was realized that farmers with relatively big land tend to adopt agroforestry more compared to farmers with small land sizes.

2.7 Agroforestry Income

Agroforestry is a considerable source of income for millions of smallholder farmers in the tropics (Lillesø et al., 2011). Different scholars found that agroforestry contributes to increased production hence raising farmers' income while also mitigating environmental degradation (Glover et al., 2014; Nair PKR., 2007), hence increasing the subjective wellbeing of households (Geeta & Knight, 2007). Agroforestry plays a role in providing daily household needs such as firewood, stakes, and other services such as soil conservation (Bucagu et al., 2013). The success of agroforestry in Rwanda depends on the impact of agroforestry on food production and income, the risk of failure due to climate change, access to markets, and farmers' familiarity with agroforestry (Stainback et al., 2011).

In the suburban areas of the Gasabo district mostly in Nduba and Gikomero sectors where this study was conducted, agroforestry is highly regarded mainly due to the possibility of huge amounts of savings that are used to be spent on purchasing firewood, tree poles, and wood for their households' daily needs. In these areas, where the cost of food, fruits, firewood, tree poles, and timber is relatively high, the agroforestry system demonstrates its super ability to provide outstanding solutions for home basic needs.

2.8 Summary and Research Gap

Agroforestry impacts the livelihoods of rural farmers while sustaining the environment. The benefits of agroforestry increase with increased adoption. The extent to which agroforestry impacts the livelihood of smallholder farmers is proportional to its acreage and the outputs it provides in addition to income obtained from selling and utilizing agroforestry products (Adebe et al., 2019; Lillesø et al., 2011; Glover et al., 2014).

Household demographic characteristics and agroforestry land size are the main factors that affect the level of adoption of agroforestry while the type of agroforestry practices and inputs enhance the level of income among smallholder farmers (Ndayambaje & Mohren, 2014; Naznin et al.,2015).

Although previous studies on agroforestry have focused on its technology, adoption, and benefits to the environment (Adebe et al., 2019; Bucagu et al., 2013; Kiyani, 2017), the influence of agroforestry practices on household wellbeing has been not often been considered. This gap has derailed the adoption of agroforestry among smallholder farmers and this scenario is likely to persist. The influence of household demographic characteristics, agroforestry practices applied, agroforestry inputs used, agroforestry land size, as well as agroforestry income on the subjective wellbeing of households, needs to be established. To that end, this study has been designed to assess the influence of agroforestry and demographic characteristics on the subjective wellbeing of households practicing agroforestry. The results of this study generated information with empirical evidence that could lead to the successful adoption of agroforestry amongst smallholder farmers, thus contributing to the subjective wellbeing of their households.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides details about the research design, research site, target population, study sample, and data collection. The research design illustrates the strategy applied to achieve the objective of this study. The research site section covers the geographical area in which this study was carried out. For the section on the target population and study sample, an overview of the category of respondents, the sample size, and sampling procedures of the study are detailed. The section on data collection describes instruments for data collection and its testing, data reliability, and validity besides data collection procedures. Lastly, this chapter also contains methods that were used in data processing, data analysis, and the presentation of results.

3.2 Research Design

This study followed a cross-sectional design (Olsen & George, 2004). This type of study design was suitable for this work given that it gave room to collecting data on agroforestry and the subjective wellbeing of households using a questionnaire. It also facilitated the description of collected data, analysis of the selected sample, and conclusions about the influence of agroforestry on the subjective wellbeing of households.

3.3 Research Site

Geographically, this study was carried out in Nduba and Gikomero sectors of Gasabo district, Rwanda. Gasabo is the most rural and one of three districts that constitute Kigali

city. Gasabo district occupies around 2/3 of the whole Kigali city, and the major economic activity for its inhabitants is agriculture. The total area of Gasabo is 430.30 Km^2 while its total population is 529,561 (NISR, 2012). Gasabo district is located on the outskirts of Kigali city and has been selected as the most relevant site for this study due to its farmers' uniqueness in promoting agroforestry as the most viable source of income and fuelwood energy, which is highly expensive compared to other areas in the country. Nduba and Gikomero sectors (Figure 3.1), in which this study was conducted, were chosen since agroforestry has been promoted in them among farmer-members of Zamuka cooperative since 2008.

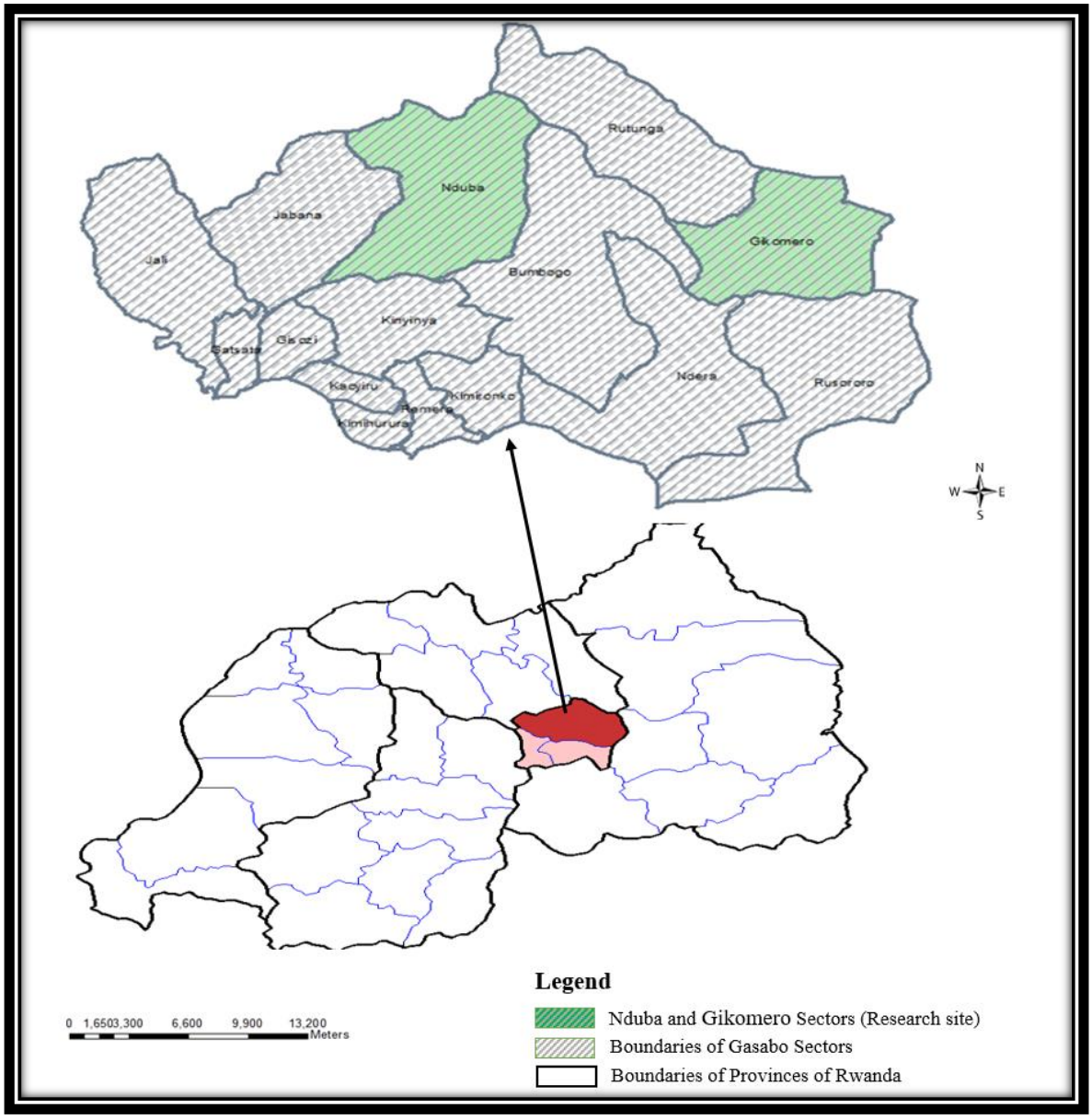


Figure 3.1 Location of Research Site on the Map of Rwanda

Source: Jean Luc Mutagoma, 2021

3.4 Target Population

This study was conducted on a population of 910 households who are members of Zamuka cooperative and who practice agroforestry in Nduba and Gikomero sectors of Gasabo district. Zamuka cooperative was selected as its members have been practicing agroforestry since 2008. Zamuka farmers have been beneficiaries of a project called "Market-oriented agroforestry for livelihood improvement in Zamuka cooperative, Gasabo district". This project was funded by Vi Agroforestry, a Swedish non-governmental organization that has been working with farmers in promoting agroforestry in Gasabo district since 2008. Through this project, members of Zamuka have been supported on agroforestry enterprise establishment. After being trained on various technical competencies and being taken for study tours, farmers were provided with agroforestry farm inputs mainly organic manure, improved seeds, and livestock besides tree seedlings to improve their farming enterprises using agroforestry. All of these inputs lead to the adoption of agroforestry and the establishment of banana agroforestry demo farms at the household level, which currently serve as role models to the rest of the community on market-oriented agroforestry.

3.5 Sampling

3.5.1 Sample Size

The required sample population for this study was randomly selected among household members of Zamuka cooperative, who practice agroforestry in Nduba and Gikomero sectors of Gasabo district.

The sample size was determined using the formula of Krejcie and Morgan (1970):

$$S=(\chi 2NP(1-P)) \div (d^2(N-1) + \chi 2P(1-P))$$

Where:

S= The required sample size.

$\chi 2$= The table value of chi-square for one degree of freedom relative to the desired level of confidence which is 0.95 [The chi-square value used is 3.841].

N = The population size with the study area [910].

P = Population proportion [assumed to be 0.50 because the true proportion is unknown], as this magnitude yields the maximum possible sample size required.

ME =d= desired margin of error [expressed as proportion]. This is the degree of accuracy as reflected by the amount of error that can be tolerated in the fluctuation of a sample proportion of the population *P***.** The value of *d* is taken as 0.05, which is equal to plus or minus 1.96δρ. ME^2= [0.05^2=0.0025].

S=(3.841*910*0.5(1-0.5)) ÷ (0.05^2(910-1) + 3. 841*0.5(1-0.5))=270

Based on the population of the area (910) and the above formula, the required sample size was calculated to be 270 households.

3.5.2 Sampling Procedure

The sampling procedure followed a stratified random sampling to avoid biases. The two sectors Nduba and Gikomero in Gasabo district were taken as the strata of the study. The households within the two strata were randomly selected using a systematic sampling method.

Proportional allocation based on the location of cooperative members was used to select the number of households in each stratum. The sample size distribution has been summarized in Table 3.1.

Table 3.1 Sample Size Distribution in Strata Based on Population Proportions

Strata	Population	Proportion	Sample allocation
Nduba	310	0.34	92
Gikomero	600	0.66	178
Total	**910**	**1**	**270**

3.6 Data Collection

3.6.1 Data Collection Instruments

A survey questionnaire was the main study instrument. The questionnaire was in the English language and research assistants that master both English and Kinyarwanda were utilized to translate the questionnaire for respondents. Designing the questionnaire was based on the constructs from the conceptual framework.

3.6.2 Pilot Testing of the Questionnaire

Before proceeding with data collection, a pilot test of the research questionnaire was carried out on 25 households which equals 10% of the target population. Information gathered from the pilot testing was utilized to assess the reliability and validity of the survey questionnaire. Participants in the pilot test did not participate in the main study, and data collected during the pilot test were not used in the main study.

3.6.3 Instrument Reliability

Information collected from the pilot testing was used to assess the reliability of the survey questionnaire. Cronbach's alpha reliability test was used to measure the consistency of results provided by the questionnaire. Data collected during the pilot test helped to calculate the Cronbach's alpha (α) that in turn helped to understand the variance of our test scores. The Cronbach test formula is as shown below:

$$\alpha = Np/[1+p(N-1)]$$

Where N=Total number of items

P=Mean inter-item correlation

The minimum acceptable Cronbach alpha (α) coefficient is 0.7 on the scale of Cronbach alpha (α) coefficients ranging from 0.5 (Unacceptable value) to 0.9 (Excellent value). The calculated Cronbach's alpha coefficient was 0.937 which was greater than 0.7, therefore the survey questionnaire was confirmed as a reliable data collection instrument.

3.6.4 Instrument Validity

The validity of the survey questionnaire was determined through a two-round test process during the pilot test of 27 households in Bumbogo sector and the data obtained during the test helped to assess and confirm its consistency and accuracy. During the whole test exercise, the feedback obtained in each round was utilized to upgrade the questionnaire until the level of information it provided met the expected consistency and accuracy to confirm that it was capable to measure what it was supposed to measure.

3.6.5 Data Collection Procedure

After designing the questionnaire, ensuring its validity and reliability, and arranging the appointment with respondents, a workshop training for research assistants was done. The workshop training was about understanding and mastery of the survey questionnaire survey. In this workshop, guidelines on using the survey questionnaire were detailed, evaluated, and confirmed. Also, an open discussion for any obscure point of questionnaire discussed. The process of collecting data from the selected sample was carried out by seven enumerators who worked collectively in both strata. It was necessary to translate the questionnaire into the local language to facilitate the respondents to answer questions and wherever any issue arose, enumerators assisted accordingly. After collecting the needed information, data were entered into the computer without any delay to avoid any inconvenience of losing data.

3.7 Data Processing and Analysis

Harvested data were analyzed statistically using the Statistical Packages for Social Sciences (SPSS version 20) software. Statistical analyses that were executed are Linear Regression, *t*-test methods, and Descriptive Statistics. The latter was used to present the basic features of collected quantitative data in a simple and manageable manner. Performing Linear Regression was undertaken to understand the relationship between the independent and the dependent variable in the context of our study. The *t*-test was performed to compare the means of data in different strata. The Cronbach's alpha method was utilized to test the significance of the collected data. Details about this section have been summarized in Table 3.1.

Table 3.2 Data Analysis and Statistical Tools

Objectives		Independent Variable	Dependent Variables	Method of Data Analysis
(i)	To determine the influence of household demographic characteristics on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda	Household demographic characteristics	Household subjective wellbeing	Descriptive Statistics and Inferential Statistics
(ii)	To investigate the influence agroforestry practices applied on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda	Agroforestry practices applied	Household subjective wellbeing	Descriptive Statistics and Inferential Statistics
(iii)	To examine the influence of using agroforestry inputs on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda	Agroforestry inputs used	Household subjective wellbeing	Descriptive Statistics and Inferential Statistics
(iv)	To study the influence of agroforestry land size on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda	Agroforestry land size	Household subjective wellbeing	Descriptive Statistics and Inferential Statistics
(v)	To assess the influence of agroforestry income on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda	Agroforestry income	Household subjective wellbeing	Descriptive Statistics and Inferential Statistics

3.8 Ethical Considerations

The ethical requirements for academic work oblige to apply for research permits and get signed consent before proceeding with different phases of the research, and all of these conditions were respected accordingly. To that end, the permit from the academic ethics committee was provided, and the permit from the local authority was solicited before heading to data collection. Before answering to survey questionnaire, the consent from respondents was obtained, and then respondents were ensured of privacy for their information, not mentioning their names, keeping every information confidential, and holding every information secretly

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter presents results and their interpretation of the assessment of the influence of agroforestry and demographic characteristics on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda. The chapter is divided into the following sections: (i) Characteristics of respondents, (ii) Influence of agroforestry practices on the subjective wellbeing of households, (iii) Influence of agroforestry inputs on subjective wellbeing of households, (iv) Influence of agroforestry land size on the subjective wellbeing of households, and (v) Influence of agroforestry income on the subjective wellbeing of households.

4.2 Characteristics of the Respondents

The characteristics of the respondents interviewed were placed into four categories namely age, sex of the household head, household size, and the level of formal education of the household head.

4.2.1 Age

To get the information about the age of the household head, the respondents were asked to state the year in which they were born and this helped to calculate their age. Table 4.1 shows the frequency distribution and the descriptive statistics of the respondents' age.

Table 4.1 Age Distribution of the Respondents

Age Categories in Years	Frequency	Percent
Below 30 years	19	7.0
31-60 years	246	91.1
Above 60 years	5	1.9
Total	**270**	**100.0**

Mean age 46±.56, median 46, mode 51, std. dev 9.2, min 26, max 70.

Table 4.1 shows that for the surveyed 270 respondents, a high percentage of respondents were concentrated in age from 31 to 60 years while the mean was 46 years. The chi-square test for equality of categories of the age groups was shown in Table 4.2.

Table 4.2 Chi-square Test for Equality of Categories for the Age Groups

Age in Years	Observed N	Expected N	Residual	Statistics
Below 30 years	19	90.0	-71.0	$\chi 2$ =136.27
31-60 years	246	90.0	156.0	*df*=3
Above 60 years	5	90.0	-85.0	p <.001
Total	**270**			

The chi-square test revealed statistically significant differences among the different categories of respondents' age groups, $\chi 2$ (2, N=270)=136.27, p =.001). The category of age from 31 to 60 years was significantly higher than the other categories, indicating that the majority of the household heads have ages ranging from 31 to 60 years in Nduba and Gikomero sectors of Gasabo district, Rwanda.

4.2.2 Sex of the Household Head

The gender of the household was considered during data collection and the results were presented in Table 4.3.

Table 4.3 Sex of the Household Head

Sex	Frequency	Percent
Male	159	58.9
Female	111	41.1
Total	**270**	**100.0**

Out of the total sampled respondents, the majority were males (60%) compared to females (41%).

4.2.3 Level of Formal Education of the Household Head

The respondents were asked to provide their level of formal education and the results of the analysis were presented in Table 4.4.

Table 4.4 Level of Formal Education of the Household Head

Level of formal education	Frequency	Percent
No formal education	22	8.1
Primary	215	79.6
Technical school	8	3.0
Secondary	23	8.5
University	2	0.7
Total	**270**	**100.0**

Results from Table 4.4 show that the majority of respondents (79.6%) have a primary level of education, followed by secondary level (9%), no formal education (8.1%), technical school (3%), and university (1%).

4.2.4 Household size

The household number was another characteristic that was asked respondents during the interview and the results of the analysis were presented in Table 4.5.

Table 4.5 Percentage of Respondents by the Household Size

Household size	Frequency	Percent
1 to 2	20	7.4
3 to 4	113	41.9
5 to 6	137	50.7
Total	**270**	**100.0**

Mean 4±.07, median 5, mode 5, std. dev 1.14, min 1, max 6.

Results from Table 4.5 show that the majority of respondents' households (51%) have a family with 5 to 6 members followed by households with 3 to 4 members (42%), and lastly households with 1 to 2 members (7%). The average family size is 4.

4.2.5 Household Land Size

The household land size was asked of the respondents and the results of the analysis were summarized in Table 4.6.

Table 4.6 Percentage of Respondents by Household Land Size

Land Size in Hectares	Frequency	Percent
0.1 to 1	227	84.1
1.1 to 2	40	14.8
2.1 to 3	3	1.1
Total	**270**	**100.0**

Mean hectares 0.7±.02, median 0.7, mode 1, std. dev 0.39, min 0.3, max 3.

Results from Table 4.6 show that the majority of respondents (84%) had land below 1 hectare, followed by the category of respondents with land ranging from 1.1 to 2 hectares (15%) and the rest (1%) with 2.1 to 3 hectares.

4.3 Subjective Wellbeing of Households

The dependent variable for this study is the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda. The variable measured the level of subjective wellbeing of households in Gasabo district and was operationalized as an index that includes 7 domains: Standard of living, Health status, Spirituality/Religiosity, Quality of environment, Emotions, and affiliations, Community connectedness, and Future security. The subjective wellbeing index was calculated based on responses to 20 asked questions on 7 domains mentioned above. Each question was a rank of a single choice question on a scale from 0 (not assisted) to 10 (highly assisted). Each domain value was calculated by making an average of values of its compound questions. Thereafter, the subjective wellbeing index was calculated by taking the average of all seven domains as shown in Table 4.7.

Table 4.7 Descriptive Statistics of Indices of Domains Used to Compute the Subjective Wellbeing Index

	Descriptive statistics				
Domains	**Mean**	**Median**	**Mode**	**Std. Dev.**	**Range**
Standard of living	6.55	6.80	7.00	2.07	15
Health status	8.97	10.00	10.00	1.72	10
Spirituality/Religiosity	8.12	8.50	10.00	1.98	9
Quality of environment	6.62	6.60	6.40	1.66	8
Emotions and affiliations	7.34	8.00	8.00	2.09	9
Community connectedness	6.20	6.00	5.25	1.84	9
Future security	7.80	8.00	10.00	1.91	8
Subjective Wellbeing Index	**7.00**	**7.00**	**7.00**	**1.51**	**8**

Thereafter, the subjective wellbeing index was categorized into five groups, as follows: 1-2.99 very low, 3-4.99 low, 5-6.99 moderate, 7-8.99 high, and 9-10 very high. The descriptive statistics and the frequency distribution for the subjective wellbeing index in five categories are shown in Table 4.8. The details in each category of the subjective wellbeing index were presented in Appendix C.

Table 4.8 Subjective Wellbeing Index Distribution for the Respondents

Index Categories	Frequency	Percent
1 to 2.99	2	.7
3 to 4.99	25	9.3
5 to 6.99	99	36.7
7 to 8.99	124	45.9
9 to 10	20	7.4
Total	**270**	**100.0**

Mean 6.99±.09, median 0.09, mode 6.75, std.dev 1.5, min 2.1, max 10.

The subjective wellbeing indices were grouped into five categories as described in Table 4.8. Most of the respondents are in the subjective wellbeing index category ranging from 7 to 8.99 subjective wellbeing. The chi-square test for the equity of categories for the subjective wellbeing index groups was presented in 4.9.

Table 4.9 Chi-square Test for Equality of Categories for the Subjective Wellbeing Index Groups

	Observed N	Expected N	Residual	Statistics
1 to 2.99	2	54.0	-52.0	$\chi 2$=215.296
3 to 4.99	25	54.0	-29.0	*df*=4
5 to 6.99	99	54.0	45.0	p <.001
7 to 8.99	124	54.0	70.0	
9 to 10	20	54.0	-34.0	
Total	**270**			

The chi-square test revealed statistically significant differences among the different categories of respondents' subjective wellbeing index; $\chi 2$ (4, N = 270) = 215.296, p < .001).

The category of 7 to 8.99 was significantly higher than the other categories, indicating that the majority of the farmers had a very high level of subjective wellbeing index.

4.4 Influence of Household Demographic Characteristics on the SubjectiveWellbeing

The first objective of this study was to determine the influence of household demographic characteristics on the subjective wellbeing of households practicing agroforestry in Gasabo District, Rwanda. The selected household characteristics include age, gender, education level, and household size.

4.4.1 Influence of Age on the Subjective Wellbeing

The influence of age on the subjective wellbeing was determined by use of simple linear regression analysis. The independent variable was age and the independent variable was subjective wellbeing. The model summary showing the R square is given in Table 4.10.

Table 4.10 Regression Model Summary for Age and the Subjective Wellbeing Index

R	*R* Square	Adjusted *R* Square	Std. Error of the Estimate
.022	.003	-.003	1.509

The *R* Square value in the regression model indicates that the independent variable of age is explained approximately 2.2% of the variation in the dependent variable subjective wellbeing index. The *F*-test for the regression model is shown in Table 4.11.

Table 4.11 ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	***df***	**Mean Square**	***F***	***p***
Regression	.289	1	.289	.127	.722
Residual	610.862	268	2.279		
Total	**611.150**	**269**			

Dependent Variable: Subjective wellbeing Index
Predictors: Age

The overall regression model was not positively significant (F (1, 269) = .127, p >.05). The regression coefficients of the model showing the beta, t-statistics, and the collinearity statics are shown in Table 4.12.

Table 4.12 Regression Coefficients for Age

	Unstandardized Coefficients		**Standardized Coefficients**			**Collinearity Statistics**
	B	**Std. Error**	***Beta***	***t***	***P***	***VIF***
(Constant)	6.835	.466		14.66	.001	
Age	.004	.010	.022	.356	.722	1.000

Dependent Variable: Subjective wellbeing index

The regression analysis shows that age has no significant ($ß$ = .004, t (269) = .356, p >.05) effect on the wellbeing index in Nduba and Gikomero sectors of Gasabo district.

4.4.2 Influence of the Household Size on the Subjective Wellbeing

The subjective wellbeing index was analyzed about the household size within Nduba and Gikomero sectors of Gasabo district, Rwanda.

Table 4.13 Regression Model Summary for Household size and the Subjective Wellbeing Index

R	*R* Square	Adjusted *R* Square	Std. Error of the Estimate
.054	.003	-.001	1.507

Predictors: (Constant), Household size
Dependent Variable: Subjective wellbeing index

The *R* Square value in the regression model indicates that the independent variable of household size is explained approximately 5.4 % of the variation in the dependent variable subjective wellbeing index. The *F*-test for the regression model is shown in Table 4.14.

Table 4.14 ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	*df*	Mean Square	*F*	*p*
Regression	1.773	1	1.773	.780	.378
Residual	609.377	268	2.274		
Total	**611.150**	**269**			

Dependent Variable: Subjective wellbeing index
Predictors: (Constant), Household size

The overall regression model was not positively significant (F (1, 269) = .780, p >.05).

The regression coefficients of the model showing the beta, t-statistics, and the collinearity statics are shown in Table 4.15.

Table 4.15 Regression Coefficients for household size

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics
	B	**Std. Error**	***Beta***	***t***	***p***	***VIF***
(Constant)	6.684	.366		18.246	.001	
Household size	.071	.080	.054	.883	.378	1.000

Dependent Variable: Subjective wellbeing index

The regression analysis shows that household size has no significant (*ß* = 6.684, *t* (269) = 18.246, *p* >.05) effect on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda.

4.4.3 Influence of the Sex of the Household Head on the Subjective Wellbeing

The data was analyzed to determine the means of male and female-headed households' wellbeing index in Gasabo district, and the results are shown in Table 4.16.

Table 4.16 Descriptive Statistics of Male and Female Households Heads' Subjective Wellbeing Index

Sex	N	Mean	Std. Deviation	Std. Error Mean
Male	159	7.2	1.419	.112
Female	111	6.6	1.565	.148

The mean subjective wellbeing index for the male-household heads was higher (7.2) than the mean subjective wellbeing for the female household headed (6.6). The *t*-test for the distribution of the heads of households and Levene's Test for Equality of Variances are shown in Table 4.17.

Table 4.17 Mean Comparison between the Male and Female Heads of Households

	Levene's Test		t-test for Equality of Means			
	F	***p***	***t***	***df***	***p***	**Mean Difference**
Equal variances assumed	.996	.319	3.265	268	.001	.598
Equal variances not assumed			3.209	221.694	.002	.598

The difference in subjective wellbeing index for both the male and female household heads was statistically different (t (268) = 3.26, p = .001)).

4.4.4 Influence of Education of the Household Head on the Subjective Wellbeing

The subjective wellbeing index was analyzed about the education levels within Nduba and Gikomero sectors of Gasabo district, Rwanda. The analysis was done to determine which of the five levels of education had the highest mean in terms of the wellbeing index, and the ANOVA was conducted to compare these means. The descriptive statistics (means, standard deviation, standard error, and minimum and maximum values) of the five education levels are shown in Table 4.18.

Table 4.18 Descriptive Statistics for Subjective Wellbeing Index for the Education Levels

Education levels	**Mean**	**Std. Dev.**	**Std. Error**	**Min.**	**Max.**
No formal education	6.3	1.335	0.285	3.35	8.35
Primary	7.0	1.518	0.104	2.10	10.00
Technical school	8.0	0.869	0.307	6.75	9.30
Secondary	7.0	1.576	0.329	2.80	10.00
University	8.2	0.071	0.050	8.15	8.25
Total	**7.00**	**1.507**	**0.092**	**2.10**	**10.00**

The results (Table 4.18) for the five education levels indicate that household heads with a university level of education had the highest mean subjective wellbeing index, followed by technical school, secondary level, primary level, and finally no formal education.

The main purpose of running the one-way ANOVA was to establish whether there were any statistically significant differences in the subjective wellbeing index among the five levels of formal education. The result of the one-way ANOVA for the mean comparisons is shown in Table 4.19.

Table 4.19 ANOVA Table for Mean Comparisons Showing the *F*-test

	Sum of Squares	***df***	**Mean Square**	***F***	***p***
Between Groups	20.613	4	5.153	2.312	.058
Within Groups	590.538	265	2.228		
Total	**611.150**	**269**			

The *F*-test (Table 4.19) results indicate that there was no statistically significant difference in the subjective wellbeing index for the five education levels, (F (4,265) = 2.312, p >.058).

4.5 Influence of Agroforestry Practices on the Subjective Wellbeing of Households

The second objective of this study was to investigate the influence of agroforestry practices on the subjective wellbeing of households in Nduba and Gikomero sectors of Gasabo District, Rwanda. Two variables namely the number of agroforestry practices applied and types of agroforestry practices were selected to investigate the influence of agroforestry practices on the subjective wellbeing of households.

4.5.1 Agroforestry Practices

This was determined as the number of practices adopted by the household in their farming practices.

In the context of this study, agroforestry practices applied were intercropping, alley cropping, scattered trees on the farm, contour hedgerows, fodder banks, home gardens, shelterbelts, windbreaks, and woodlots among others. The descriptive statistics for the number of agroforestry practices applied have been summarized in Table 4.20.

Table 4.20 Descriptive Statistics for Number of Agroforestry Practices Applied

Number of practices	Frequency	Percent
1	6	2.2
2	36	13.3
3	52	19.3
4	58	21.5
5	46	17.0
6	27	10.0
7	24	8.9
8	13	4.8
9	6	2.2
10	1	.4
11	1	.4
Total	**270**	**100.0**

Mean 4.4 ±.11, median 4, mode 4, std.dev 1.93, min 1, max 11.

Results from Table 4.20 show that the majority of respondents (22%) applied 4 agroforestry practices on their farm, followed by the category of respondents with 3 agroforestry practices (19%), and 5 agroforestry practices (17%), and so on.

4.5.2 Influence of Agroforestry Practices on the Subjective Wellbeing

The respondents were asked questions to determine the influence of the agroforestry practices on the subjective wellbeing of households and the results of the analysis of the influence of agroforestry practices on the subjective wellbeing of households were presented in Table 4.21.

Table 4.21 Regression Model Summary for Agroforestry Practices and the Subjective Wellbeing Index

R	*R* Square	Adjusted *R* Square	Std. Error of the Estimate
.504	.254	.251	1.304

The *R* square value of 0.254 means that the number of agroforestry practices explained 25% of the variation in the wellbeing Index. The *F*-test for the regression model is shown in the ANOVA Table 4.22.

Table 4.22 ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	*df*	Mean Square	*F*	*p*
Regression	155.266	1	155.266	91.276	.001
Residual	455.885	268	1.701		
Total	**611.150**	**269**			

The overall regression model was found significant (F (1, 268) = 91.276, p =.001). The regression coefficients of the model showing the beta, *t*-statistics, and the collinearity statistics are shown in Table 4.23.

Table 4.23 Regression Coefficients for the Number of Agriculture Practices

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics
	B	**Std. Error**	**Beta**	***t***	***p***	**Tolerance**
(Constant)	5.243	.200		26.213	.001	
Number of agroforestry practices	.393	.041	.504	9.554	.001	1.000

The regression analysis shows that the number of agroforestry practices has a significant (ß = .504, t = 9.554, p = .001) positive effect on the subjective wellbeing index of households practicing agroforestry inGasabo district, Rwanda.

4.6 Influence of Agroforestry Inputs on the Subjective Wellbeing of Households

To determine the influence of using agroforestry inputs on the subjective wellbeing of households in Nduba and Gikomero sectors of Gasabo district of Rwanda, the agroforestry inputs used by a household was studied in relation to the subjective wellbeing.

4.6.1 Agroforestry Inputs

Four types of agroforestry inputs used by a household namely: organic manure, improved crop seed, improved livestock breeds, and tree seedlings inputs were used to determine the influence of inputs on the subjective wellbeing of households. Descriptive statistics for the number of agroforestry inputs used have been summarized in Table 4.24.

Table 4.24 Descriptive Statistics for Number of Agroforestry Inputs Used

No of agroforestry inputs use	Frequency	Percent
1	20	7.4
2	44	16.3
3	61	22.6
4	21	7.8
5	75	27.8
6	30	11.1
7	19	7.0
Total	**270**	**100.0**

Mean 3.4±.10, median 4, mode 5, std.dev 1.7, min 1, max 7.

Results from Table 4.24 show that the majority of respondents (28%) applied 5 agroforestry inputs on their farm, followed by the category of respondents with 3 agroforestry practices (23%), and 2 agroforestry inputs (16%).

4.6.2 Influence of Agroforestry Inputs

The respondents were asked information about how agroforestry inputs used influence their subjective wellbeing and the results of the analysis were summarized in Table 4.25.

Table 4.25 Regression Model Summary for Agroforestry Inputs and the Subjective Wellbeing Index

R	*R* Square	Adjusted *R* Square	Std. Error of the Estimate
.418	.174	.171	1.372

The *R* square value indicated in the model means that the number of agroforestry inputs explained approximately 17% of the variation of the subjective wellbeing index. The *F*-test for the regression model was shown in the ANOVA Table 4.26.

Table 4.26 ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	***df***	**Mean Square**	***F***	***p***
Regression	106.631	1	106.631	56.642	.001
Residual	504.519	268	1.883		
Total	611.150	269			

The overall regression model was found significant (F (1,268) = 56.642, p <.001). The regression coefficients of the model showing the beta, *t*-statistics, and the collinearity statistics are shown in Table 4.27.

Table 4.27 Regression Coefficients for the Number of Agroforestry Inputs

	Unstandardized Coefficients		**Standardized Coefficients**			**Collinearity Statistics**
	B	**Std. Error**	**Beta**	***t***	***p***	**Tolerance**
(Constant)	5.543	.210		26.340	.001	
Agroforestry inputs	.369	.049	.418	7.526	.001	1.000

The regression analysis shows that the number of agroforestry inputs has a significant positive effect on the subjective wellbeing index in Nduba and Gikomero sectors of Gasabo district of Rwanda ($ß$ = .418, t (269) = 7.526, p =.001).

4.7 Influence of Agroforestry Land Size on the Subjective Wellbeing of Households

The fourth objective of this study was to study the influence of agroforestry land size on the subjective wellbeing of households practicing agroforestry in gasabo District, Rwanda. Acreage under agroforestry was used as a characteristic to study the influence of agroforestry land size on the subjective wellbeing of households.

4.7.1 Agroforestry Land Size

Acreage under agroforestry refers to the land size on which a household applies its agroforestry farming practices. Descriptive statisctics for the agroforestry land size have been summarized in Table 4.28.

Table 4.28 Distribution of Farmers by Land Size

Land size group	Frequency	Percent
0.1 to 1	227	84.1
1.1 to 2	40	14.8
2.1 to 3	3	1.1
Total	**270**	**100.0**

Mean 0.76±.7, median 0.7, mode 0.6, std.dev 0.39, min 0.3, max 7.

Results from Table 4.28 show that the majority of respondents (84%) have a farm size below 1 hectare.

4.7.2 Influence of Agroforestry Land Size

The respondents were asked questions to determine how the agroforestry acreage influences their subjective wellbeing. Results of the regression model were summarized in Table 4.29.

Table 4.29 Regression Model Summary for the Area (in Hectares) under Agroforestry and the Subjective Wellbeing Index

R	*R* Square	Adjusted *R* Square	Std. Error of the Estimate
.196	.039	.035	1.480

The *R* square value indicated by the model above means that the area (in Hectares) under agroforestry number explained approximately 4% of the variation in the subjective wellbeing index. The *F*-test for the regression model is shown in the ANOVA Table 4.30.

Table 4.30 ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	*df*	Mean Square	*F*	*p*
Regression	23.569	1	23.569	10.750	.001
Residual	587.581	268	2.192		
Total	**611.150**	**269**			

The overall regression model was positively significant (F (1,268) = 10.750, p <.001). The regression coefficients of the model showing the beta, *t*-statistics, and the collinearity statistics are shown in Table 4.31.

Table 4.31 Regression Coefficients for the Agroforestry Land Size

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics
	B	**Std. Error**	**Beta**	***t***	***p***	***VIF***
(Constant)	6.291	.233		26.951	.001	
The area (Ha) under agroforestry	1.252	.382	.196	3.279	.001	1.000

The regression analysis shows that the area under agroforestry has a significant positive effect on the subjective wellbeing index of households practicing agroforestry in Gasabo District, Rwanda ($ß$ = .196, t (269) = 3.279, p = .001).

4.8 Influence of Agroforestry Income on the Subjective Wellbeing of Households

The fifth objective of this study was to assess the influence of agroforestry income on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda. The agroforestry products utilized and agroforestry products sold were studied to assess the influence of agroforestry income on the subjective wellbeing of households.

4.8.1 Income from Agroforestry

Agroforestry income referred to here in this study stands for the total household income obtained by selling agroforestry products and/or household income saved by utilizing agroforestry products. The descriptive statistics for the agroforestry income per household has been summarized in Table 4.32.

Table 4.32 Distribution of Farmers by Agroforestry Income Categories

Income Category in Rwandan Francs	Frequency	Percent
1-100,000	40	14.8
100,001-200,000	82	30.4
200,001-300,000	65	24.1
300,001-400,000	40	14.8
400,001-500,000	15	5.6
500,001-600,000	28	10.4
Total	**270**	**100.0**

Results of Table 4.30 show that the majority of respondents (30%) are within the income category of 100,001-200,000, followed by respondents (24%) in the income category of 200,0001-300,000, and so on.

4.8.2 Influence of Agroforestry Income on the Subjective Wellbeing

During the interview, the respondents were asked questions to understand the influence of agroforestry income, and the results of the regression model for this variable were summarized in Table 4.33.

Table 4.33 Regression Model Summary for Agroforestry Income and the Subjective Wellbeing Index

R	*R* Square	Adjusted *R* Square	Std. Error of the Estimate
.485	.235	.232	1.321

Predictors: (Constant), Agroforestry income

Dependent Variable: Subjective wellbeing index

The *R* square value indicated by the model means that the agroforestry income explained approximately 23% of the variation in the wellbeing index. The *F*-test for the regression model is shown in the ANOVA Table 4.34.

Table 4.34 ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	***df***	**Mean Square**	***F***	***p***
Regression	143.470	1	143.470	82.215	.001
Residual	467.680	268	1.745		
Total	**611.150**	**269**			

The overall regression model was found significant (F (1, 268) = 82.215, p <.001). The regression coefficients of the model showing the beta, t statistics, and the collinearity statistics are shown in Table 4.35.

Table 4.35 Regression Coefficients for Agroforestry Income

	Unstandardized Coefficients		**Standardized Coefficients**			**Collinearity Statistics**
	B	**Std. Error**	**Beta**	***t***	***p***	***VIF***
(Constant)	5.750	.159		36.102	.001	
Agroforestry income	.000	.000	.485	9.067	.001	1.000

Dependent Variable: Subjective wellbeing index

Predictors: (Constant), Agroforestry income

The regression analysis shows that the agroforestry income has a significant (ß = .485, *t* (269)= 9.067, *p* =.001) effect on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda

CHAPTER FIVE

DISCUSSIONS, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the findings, their discussion, conclusions, and recommendations.

5.2 Summary of the Study

This study aimed at assessing the influence of agroforestry and demographic characteristics on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda. The study specifically examined five agroforestry factors that influence the subjective wellbeing of households, these include Household demographic characteristics (Age, Gender, Education Level, and Household Size), Agroforestry practices applied (Number of agroforestry practices and Types of agroforestry practices applied), Agroforestry inputs used (Organic manure, Improved crop seed, Improved livestock breeds, and Tree seedlings), Agroforestry land size (Acreage under agroforestry), and Agroforestry income **(**Agroforestry products utilized and/or Agroforestry products sold).

To achieve these objectives, the study used primary data which was collected using a structured questionnaire that was organized according to the key areas corresponding to specific objectives of the study such as household demographic characteristics; Agroforestry practices applied; Agroforestry inputs used; Agroforestry land size, and Agroforestry income. The study utilized descriptive statistics and inferential statistics to analyze the collected data.

The results showed that some household demographic characteristics namely age, household size, and education level have not significantly affected the subjective wellbeing of households while the gender of the household head, agroforestry practices applied, agroforestry inputs used, agroforestry land size, and agroforestry income significantly affect it.

5.3 Discussions

The study findings of this study are discussed based on the specific objectives stated in section 1.5 of this thesis.

5.3.1 Influence of Household Demographic Characteristics on the Subjective Wellbeing of Households

In the area of study, the wellbeing of household demographic characteristics was very high. Except for the sex of the household head, other demographic characteristics namely age, household size, and education level showed no significant influence on the subjective wellbeing of households. This could be attributed to the fact that every household in Gasabo district, the suburban area of Kigali, despite their age, education level, and household size, their subjective wellbeing relies on various factors other than agroforestry practice.

The research findings in this study showed that age has no significant effect on the subjective wellbeing of households practicing agroforestry in Gasabo district and this can be attributed to respondents who are majorly of advanced age.

Contrary to this finding, a study in South Korea showed that age was among household demographic characteristics influencing negatively the subjective wellbeing of households (Park and Joshanloo, 2019).

Kenneth et al (2010) established that age determines the roles of people in society thus shaping the labor subdivision within members of households.

The household size also was found not to significantly affect the subjective wellbeing of households. Contrary to the findings of this study, Antonucci & Akiyama (1995) stated that family relations tend to negatively affect the subjective wellbeing of households. A different study proved that in rural areas, household size manifests a positive effect in enhancing the subjective wellbeing of households, resulting in increased farm production through the availability of enough labor capital of the household (Naznin et al., 2015). For instance, although young children divert household labor resources from agriculture, older children contribute to the farm resources such as firewood, game, and water (De Sheribinin et al., 2007).

The sex of the household head exhibited a positive significant effect on the subjective wellbeing of households. Thet-test showed a statistically significant difference in the average subjective wellbeing index between male- and female-headed households heads (Table 4.17). Park and Joshanloo (2019) found the same and stated that gender was among the factors that influence subjective wellbeing in South Korea.

Similarly, a systematic review of the impacts of agroforestry interventions on agricultural productivity, ecosystem services, and human wellbeing in low- and middle-income countries by Castle et al., (2021) agrees with this finding.

The study by Haring and Okun (1984) found that even though they are not at the same level, composite socioeconomic status, occupational status, and income are less strongly related to subjective wellbeing than gender. Males have slightly higher subjective wellbeing than females. However, Hughes and Waite (2002) contrasted the expectation that subjective wellbeing and negative health effects vary with gender.

Among other household demographic characteristics, Education level was found to have no significant effect on the subjective wellbeing of households. This may be explained by the fact that the majority of the respondents attended a primary school which did not play an important role in their lives. Contrary to the findings of this study, other scholars found that education has a significant effect on the subjective wellbeing of households. Jeffrey & Douglas (2002) and Geeta & Knight (2007) found that education level is among the household characteristics affecting subjective wellbeing. Education is believed to bring more expectations in life such as better jobs, beneficial networks, and higher societal standing and therefore it is positively correlated to subjective wellbeing (Kristoffersen, 2018). Education, innovation, and creativity were found by Dolan and Metcalfe (2012) to have a positive effect on subjective wellbeing, where for instance 20% increase in life satisfaction was associated with the impact of having a degree and a 30% increase in happiness was equivalent to having a degree.

5.3.2 Influence of Agroforestry Practices on the Subjective Wellbeing of Households

The research findings showed that agroforestry practices have a positive significant effect on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda. The regression analysis proved that agroforestry practices have a significant positive influence on the subjective wellbeing of households (Table 4.23). This is majorly justified by various benefits generated by different agroforestry practices within the area of this study where timber for income, fodder for livestock, firewood for household cooking energy, and mulch for major crops like bananas among others. Similarly, the same results were found by Fagerholm et al (2016) that agroforestry systems provide ecosystem services that contribute to what nature supplies to humans for their wellbeing. Ewel (1999) also found that agroforestry practices make farmers happier through knowledge acquisition and creativity to adapt to specific conditions of their systems of production. The happiness of agroforestry practitioners can also be linked to the income generated by agroforestry practices. Kiyani et al (2017) and Ojedokun et al (2020) found that agroforestry practices contribute to farmers' subjective wellbeing through increased income.

The study conducted by Idumah et al (2014) found that agroforestry practices improve crop yield and farmers' income from agroforestry products that aid their wellbeing. Bastien (2018) also found that agroforestry has a positive impact on the wellbeing of farmers who practice it because it breaks the chain of farm management systems by putting the human being at the center of farming activities.

5.3.3 Influence of Agroforestry Inputs on the Subjective Wellbeing of Households

Agroforestry inputs were found to significantly and positively influence the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda (Table 4.27). The reason behind this influence is based on the fact that the more quality agroforestry inputs are utilized in agroforestry farms the more the agroforestry products are obtained and hence the income made from selling agroforestry products increases.

The finding of this work that good crop and tree seeds are essential agroforestry inputs that may increase production and thus be important to the wellbeing of smallholder families is also shared by the findings of Graudal, Lillesø & Jeans-Peter, (2007). This study also confirmed that the agroforestry seed and seedling supply system is an integral part of commercial market-oriented agroforestry value chains that encourages the operations of small, competitive seed and seedling retailers and contributes largely to their income and livelihood improvement. Lillesø et al (2011) shared their point of view that agroforestry inputs mainly quality planting materials remain a challenge to improved productivity of agroforestry farms yet they contribute a lot to increased income for farmers in the tropics hence their wellbeing.

Agroforestry impact in the area of this study has been majorly a result of quality planting materials that have been provided by the government and different stakeholders with interest in Agroforestry in the area. The influence of agroforestry on the subjective wellbeing of households in Nduba and Gikomero sectors of Gasabo has a lot to do with the effort of Vi Agroforestry, a Swedish non-governmental organization that has operated in

the area since 2008, providing training, establishing agroforestry demo farms, and facilitating study visits in addition to the provision of inputs.

Therefore, the effort of different stakeholders in promoting agroforestry value chains is of a paramount role in enhancing the different initiatives of governments to prepare and distribute agroforestry planting materials as key pre-requisites to the success of agroforestry and its contribution to the subjective wellbeing of households.

5.3.4 Influence of Agroforestry Land Size on the Subjective Wellbeing of Households

The findings of this study showed that the agroforestry land size has a significant influence on the wellbeing of households practicing agroforestry in Gasabo district, Rwanda (Table 4.31). This may be explained by the fact that the area under agroforestry for a given household determines the agroforestry outcome for the same household.

Another explanation for this finding was that in the area where this study was conducted, the average land size owned by a household was 0.7 Ha (Table 4.6), which is relatively small and obliges innovation around putting the available land to different uses that maximize the utility to increase the overall household outcome.

In their systematic review of the impacts of agroforestry interventions on agricultural productivity, ecosystem services, and human wellbeing in low-and middle-income countries, Castle et al (2021) stated that agroforestry land tenure interventions are plausible pathways for the improved wellbeing of farmers. The study by Ewel (1999) showed that agroforestry land size and land-use system applied on agroforestry farms determine the

level of the main subsistence crops, fruits, herbs, pharmaceuticals, ornamentals, and spices produced by farmers and which have a great impact on their wellbeing.

The effort of the government to increase the area under agroforestry farms with radical terraces in the steep hills of Gasabo where this study was conducted was also considered one of the major factors that increased the area under agroforestry and its effect on the subjective wellbeing of households. The methodology applied in creating radical terraces in this area, obliged the contractors to plant diverse agroforestry tree species on the ridges of terraces that increased the number and quantity of agroforestry products harvested thus increasing agroforestry income and various utilities that contributed to the subjective wellbeing of households in this area.

5.3.5 Influence of Agroforestry Income on the Subjective Wellbeing of Households

Although income should not be considered as a single determinant of wellbeing as it does for the concept of standard of living which is primarily based on GDP per capita, agroforestry income has significantly shown a positive influence on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda (Table 4.35). Being practiced in the outskirts of Kigali where a better market for agroforestry products is ensured, agroforestry received high regard from farmers. This is mainly due to the ability of agroforestry farmers to save huge income that was ordinarily used to be spent on purchasing firewood, tree poles, and wood for their households' daily needs. To that end, that may be one of the explanations for the influence of agroforestry income on the subjective wellbeing of households in this area. Other scholars have found that agroforestry contributes to increased production hence raising farmers' income while also mitigating

environmental degradation of their farms (Glover et al., 2014; Nair PKR., 2007), and in the process increasing the subjective wellbeing of households (Geeta & Knight, 2007).

It has also been found that the level of income effectively increases subjective wellbeing in developing countries (Naznin et al., 2015; Jeffrey & Douglas, 2002). The finding of this study coincides with what Ojedukun et al (2021) found in assessing determinants of wellbeing among agroforestry farmers in Edo State, Nigeria. Results of their study showed that the higher the farmers' income level, the higher the economic, social, and psychological wellbeing of farmers, hence recommending the government and NGOs to emphasize agroforestry support services like incentives, agricultural inputs, and provision of soft loans to improve farmers income thus their households subjective wellbeing.

5.4 Conclusions

The following conclusions were made from this study:

(i) Except for the sex of the household head, other demographic characteristics (age, household size, and education level) showed no significant influence on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda;

(ii) Agroforestry practices applied (number of agroforestry practices and types of agroforestry practices) showed statistically significant influence on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda;

(iii) Agroforestry inputs used (organic manure, improved crop seeds, improved livestock breeds, and tree seedlings) were found to have a positive significant

influence on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda;

(iv) Agroforestry land size (acreage under agroforestry) exhibited a positive significant influence on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda;

(v) Agroforestry income (agroforestry products utilized and agroforestry products sold) had a statistically significant positive influence on the subjective wellbeing of households practicing agroforestry in Gasabo district, Rwanda.

5.5 Recommendations

Based on the study findings, policymakers, development partners, and farmers are recommended:

(i) To consider the positive influence of the sex of the household head on the subjective wellbeing of households practicing agroforestry;

(ii) To increase the number of agroforestry practices for their positive influence on the subjective wellbeing of households practicing agroforestry;

(iii) To increase the number of agroforestry inputs used for their positive influence on the subjective wellbeing of households practicing agroforestry;

(iv) To increase the agroforestry land size for its positive influence on the subjective wellbeing of households practicing agroforestry;

(v) To increase the agroforestry income for its positive influence on the subjective wellbeing of households practicing agroforestry.

5.6 Areas of Further Research

a. Assessment of the influence of agroforestry practices on the subjective wellbeing of women-headed households in suburban and rural areas;
b. Determinants of the impact of the types of agroforestry practices on the subjective wellbeing of households in suburban and rural areas.

REFERENCES

Adebe, D.B., Alemu, M., Bluffstone, R., & Rahel, D. (2019). Household Level Determinants of Agroforestry Practices Adoption in Rural Ethiopia, Forests, Trees and Livelihoods, DOI: 10.1080/14728028.2019.1620137

Anheir, H.K., & Stares, S. (2002). *Introducing the global civil society index*. In: Glasius, Marlies, Kaldor, Mary and Anheier, Helmut K, (eds.) Global Civil Society Yearbook 2002. Oxford University Press, Oxford, UK, pp. 241-254. ISBN 9780199251681

Antonucci, T.C., & Akiyama, H. (1995). *Convoys of social relations: Family and friendships within a life span context.* In R. Blieszner & V. H. Bedford (Eds.), *Handbook of aging and the family (p. 355-371).* Greenwood Press/Greenwood Publishing Group.

Bastien, F. (2018). Agroforestry and permaculture as tools to improve farmers' wellbeing. https://bibliotecadigital.fgv.br/dspace/handle/10438/25781

Bernat, D.H., & Resnick, M.D. (2009). Connectedness in the lives of adolescents. In R. J. DiClemente, J.S. Santelli, & R. A. Crossby (Eds.) Adolescent health: Understanding and preventing risk behaviors (p.375-389). Jossey-Bass/Wiley.

Berkes, F., & Folke, C. (1998). Linking social and ecological systems for resilience and sustainability. http://hdl.handle.net/10535/4352

Bernard, F., Bourne, M., Garrity, D., Neely, C., & Chomba, S. (2019). Policy gaps and opportunities for scaling agroforestry in sub-Sahara Africa: Recommendations from a policy review and recent practice. World Agroforestry (ICRAF), Nairobi. https://www.worldagroforestry.org/publication/policy-gaps-and-opportunities-scaling-agroforestry-sub-saharan-africa

Bianca, B., Karina, M. & Melissa, J.(2019). Exploring indicators of subjective wellbeing for first-year university students, Journal of Psychology in Africa, 29:5, 480-490, DOI: 10.1080/14330237.2019.1665885

Bucagu, C., Vanlauwe, B., Wijk, M.T. Van, & Giller, K.E. (2013). Assessing farmers' interest in agroforestry in two contrasting agro-ecological zones of Rwanda. 141-158. https://doi.org/10.1007/s10457-012-9531-7

Cabanac, M. (2002). "What is emotion?" *Behavioural Processes (60)(2): 69-83.* DOI:10.1016/SO376-6357(02)00078-5

Campbell, A. (1981). Subjective measures of wellbeing. American Psychologist, 31(2), 117-124. https://doi.org/10.1037/0003-066X.31.2.117

Castle, S.E., Miller, D.C., Ordonez, P.C., Baylis, K., & Hughes, K. (2021). The impacts of agroforestry interventions on agricultural productivity, ecosystem services, and human wellbeing in low-and middle-income countries: A systematic review. *Campbell Systematic Reviews.*https://doi.org/10.1002/cl2.1167

Coulibaly, J.Y., Chiputwa, B., Nakelse, T., & Khundhlande, G. (2017). Adoption of agroforestry and the impact on household food security among farmers in Malawi. Agroforestry Systems 155 (2017) 52-69 https://doi.org/10.1016/j.agsy.2017.03.017

COWI consortium, (2018), Field Survey Report for Technical Assistance in the Preparation of Agroforestry Public Investment Projects. Revised version 18/10/2018.

Daniel, C.M., Juan, C.M., Laura, V.R., and Alberto Z. (2020). Do Trees on Farms Improve Household Wellbeing? Evidence From National Panel Data in Uganda.

De Sherbinin, A., VanWey, L., McSweeney, K., Aggarwal, R., Barbieri, A., et al. (2007). Rural household demographics, livelihoods, and environment. Global Environmental Change 18 (2008) 38-53. https://doi.org/10.1016/j.gloenvcha.2007.05.005

De Sheribinin A., Carr, D., Cassels, & Jiang, L. (2007). Population and Environment. Annual Review of Environment and Resources.vol. 32:345-373. https://doi.org/10.1146/annurev.energy.32.041306.100243

Debra, M., Lisa, W.C., & June, P. T. (2007). Inclusion of community in self scale: A single-item pictorial measure of community connectedness. Journal of community psychology, Vol.35, No. 2, 257-275, DOI:10.1002/jcop.20146

Diener, E., & Tov, E. (2011). National Accounts of Wellbeing. *Handbook of Social Indicators and Quality of Life Research, pp 137-157.* Doi: https://doi.org/10.1016/j.joep.2018.04.04.005

Diener, E. (2022). Happiness: the science of subjective well-being. In R. Biswas-Diener & E. Diener (Eds), *Noba textbook series*: Psychology. Champaig-n*-, IL: DEF publishers. Retrieved from http://noba.to/qnw7g32t

Dolan, P., & Metcalfe, R. (2012). The relationship between innovation and subjective wellbeing. http://dx.doi.org/10.1016/j.respol.2012.04.001

Elaine, C. (2013). Security and subjective wellbeing: the experience of unaccompanied young people seeking asylum in the UK. *Sociology of Health & Illness Vol. 35 No. 6 2013.* DOI:10.1111/J.1467-9566.2012.01541.x

Ewel., J.J. (1999). Natural systems as a model for the design of sustainable systems of land use. Agroforestry Systems 45(1-3), 1-21, https://doi.org/10.1023/A:1006219721151

Fagerholm, N., Oteros-Rosas, E., Raymond, C.M., Torralba, M., Moreno, G., & Plieninger, T. (2016). Assessing linkages between ecosystem services, land-use, and wellbeing in an agroforestry landscape using public participation GIS. *Applied Geography 74 (2016) 30-40 https://doi.org/10.1016/j.apgeog.2016.06.007*

Food and Agriculture Organisation of the United Nations, Rwanda. (2020). The potential of agroforestry to improve food security and land restoration. Retrieved from http://www.fao.org/rwanda/news/detail-events/en/c/1272673/

Garrity, D. (2004). Agroforestry and the achievement of the Millennium Development Goals. Agroforestry Systems 61, 5-17. https://doi.org/10.1023/B:AGFO.0000028986.37502.7c

Geeta, G.K., & Knight, J. (2007). Community, comparisons, and subjective wellbeing in a divided society. *Journal of Economic Behavior & Organisation, Vol. 64 (2007) 69-90.* Doi:10.1016/j.jebo.2007.03.004

Glover, E. K., Ahmed, H. B., & Glover, M. K. (2014). Analysis of Socio-Economic Conditions Influencing Adoption of Agroforestry Practices. January 2013. https://doi.org/10.5923/j.ijaf.20130304.09

Graudal L., & Lillesø, J-P.B. (2007). Experiences and future prospects for tree seed supply in agricultural development support: based on lessons learnt in Danida supported programmes 1965-2005. Copenhagen: Ministry of Foreign Affairs of Denmark. Danida. https://doi.org/10.1016/0167-4870(81)90003-9

Holdcroft, B. (2006). "What is religiosity?". *Catholic Education: A Journal of Inquiry and Practice. **10** (1): 89-103.*

Hughes, M.E., & Waite, L.J. (2002). Health in Household Context:Living Arrangements and Health in Late Middle Age.

Idumah, F.O., Owombo, P.T., & Ighodaro, U.B. (2014). Economics of yam production under agroforestry system in Saponba forest area, Edo State, Nigeria. *International Journal of Agriculture and Forestry, 4(6), 440-445.*

Jeanne, Y.C., Brian, C., Tabila, N., & Godfrey, K. (2017). Adoption of agroforestry and the impact on household food security among farmers in Malawi.

Jeffrey, T.B., & Dougglas, D. (2002). Subjective wellbeing and household factors in South Africa. *Social Indicators Research **65**: 333-353, 2004.*

Kenneth, V.H., Ronald, E.G., & Leisa, R.F. (2010). Demographic Characteristics of Subjective age. *The Journal of Social Psychology,* 135:4, 447-457, DOI:10.1080/00224545.1995.9712214

Kiyani, P., Andoh, J., Lee, Y., & Lee, D.K. (2017). Benefits and challenges of agroforestry adoption: a case of Musebeya sector, Nyamagabe District in the southern province of Rwanda. *Forest Science and Technology,* 13(4), 174-180. https://doi.org/10.1080/21580103.2017.1392367

Krejcie, R. V., & Morgan, D. (1970). Small-sample Techniques. The NEA Research Bulletin, 30, 607-610.

Kristoffersen, I. (2018). Great Expectations: Education and Subjective Wellbeing, a *Journal of Economic Psychology*.

Lilleso, J.B.L., Graudal, L., Moestrup, S., Kjaer, E.D., Kindt, R., Mbora, A., Dawson, I., Muriuki, J., Raebild, A., & Jamnadass, R. (2011). Innovation in input supply systems in smallholder agroforestry; seed sources, supply chains, and support systems. *Agroforestry Syst* 83, 347-359 (2011). https://doi.org/10.1007/s10457-011-9412-5

Lucas, R.E., & Diener, E. (2009). *Personality and subjective wellbeing.* In E. Diener (Ed.), *social indicators research series: Vol. 37. The science of wellbeing: The collected works of Ed Diener (p. 75-102). Springer Science + Business Media.*

Michael, P. (2003). Urban environmental quality and human wellbeing-a social geographical perspective. *Landscape and Urban Planning 65 (2003) 19-30*

Ministry of Environment of Rwanda. (2019). Launch of Rwanda Tree Planting Season 2019/2020. Retrieved from https://www.environment.gov.rw/news-detail/rwanda-launch-the-forests-planting-season-2019-2020-1

Nair, PKR. (2007). The coming age of agroforestry. https://doi.org/10.1002/jsfa.2897

National Institute of Statistics of Rwanda. (2014). Fourth Rwandan Population and Household Census 2012, January 2014.

National Institute of Statistics of Rwanda. (2018). Rwanda Poverty Profile Report 2016/2017, November 2018.

National Institute of Statistics of Rwanda. (2018). Rwanda Seasonal Agriculture Survey 2017/2018, December 2018.

National Institute of Statistics of Rwanda. (2020). Gross Domestic Product National Account, 3rd Quarter, 2020.

Ndayambaje J.D., & Mohren G.M.J. (2010). Fuelwood demand and supply in Rwanda and the role of agroforestry.*AgroforestSyst* **83,** 303-301(2021). https://doi.org/10.1007/s10457-011-9391-6

Nima, A.A., Cloninger, K.M., Persson, B.N., Sikström, S., & Garcia, D. (2020). Validation of Subjective Wellbeing Measures Using Item Response Theory. *Frontiers in Psychology*, *22 January 2020*. https://doi.org/10.3389/fpsyg.2019.03036

Ojedokun, C.A., Akinbile, L.A., Ugege, B.H., & Adebayo, D.O. (2021). Determinants of Wellbeing among Agroforestry Farmers in Edo State, Nigeria. *Dutse Journal of Pure and Applied Sciences (DUJOPAS),* Vol. 7 No. 3a September 2021. https://dx.doi.org/10.4314/dujopas.v7i3a.13

Ojedokun, C.A., Ugege, B.H., Kolade, R.I., Tunde-Francis, A.A., & Odediran, F.A. (2020). Contribution of Agroforestry to Farmers Wellbeing in Forest Enclave, Edo State, Nigeria. *Journal of Applied Sciences and Environment Management,* Vol. 24(8) 1363-1367 August 2020. https://doi.org/10.4314/jasem.v24i8.9

Olsen, C., & George, D.M. (2004). Cross-Sectional Study Design and Data Analysis. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.634.7217&rep=rep1&type=pdf

Pandit B.H., Shrestha K.K., & Bhattarai S.S. (2014). Sustainable Local Livelihoods through Enhancing Agroforestry Systems in Nepal. *Journal of Forest and Livelihood*, 12(1) October 2014.

Park., M.S-A., & Joshanloo., M. (2019). Satisfaction with life decline with age in Malaysia: an exploratory analysis of factors influencing subjective wellbeing in developing/middle-income country. https://doi.org/10.1007/s11482-019-09756-7

Perez-Soba, Marta, and Janet Dwyer. “The socio-ecological system concept.” Wageningen Environmental Research, December 6, 2016.

Petrosillo, I., Aretano, R., & Zurlini, G. (2015). Socioecological Systems. Reference Module in Earth Systems and Environmental Sciences, Elsevier, 2015. 22-July-2015. https://doi.org/10.1016/B978-0-12-409548-9.09518-X

Rwanda Environment Management Authority. (2018). Rwanda Compendium of Environment Statistics, 2018.

Rwanda Water and Forestry Authority. (2018). Rwanda to plant millions of trees during the 2018/2019 annual tree planting season. Retrieved from http://rwfa.rw/index.php?id=64&tx_news_pi1%5Bnews%5D=16&tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Baction%5D=detail&cHash=c14e28adcbc0a93146683c4f4d31781e

Sirgy, M.J., Michalos, A.C., Ferriss, A.L., Easterlin, R.A., Patrick, D., & Pavot, W. (2006). The quality of life (QOL) research movement: Past, present, and future. *Social Indicators Research*, *76*(3), 343-466. https://doi.org/10.1007/s11205-005-2877-8

Stainback, G.A., Masozera, M., Mukuralinda, A., & Dwivedi, P. (2012). Smallholder Agroforestry in Rwanda: A SWOT-AHP. 285-300. https://doi.org/10.1007/s11842-01109184-9

Stephen G.P. (2001). Household demographic factors as life cycle determinants of land use in the Amazon. Population Research and Policy Review 20: 159-186, 2001. https://doi.org/10.1111/1467-7717.00165

Tanis, T., & Henry, N. (2012). Reducing subsistence farmers’ vulnerability to climate change: evaluating the potential contributions of agroforestry in western Kenya.

World Agroforestry Centre. (2017). Corporate Strategy 2017-2020—Transforming Lives and Landscapes with Trees.

Zomer, R.J., Trabucco, A., Coe, R., & Place, F. (2009). Trees on farm: analysis of global extent and geographical patterns of agroforestry. ICRAF Working Paper-World Agroforestry Center 2009 No. 89 pp.63 pp. ref.30

APPENDICES

Appendix A: Survey Questionnaire

The Survey Questionnaire for Assessment of the Influence of Agroforestry and Demographic Characteristics on the Subjective Wellbeing of Households Practicing Agroforestry in Gasabo District, Rwanda.

Are **you willing to proceed with the interview?**

Yes ☐ No☐

Respondents details:

Names: ……... Telephone: ……...

Sector: ……. Cell: …….……... Village: …….

Instructions:

- To make sure the respondent is the head of the household;
- To respect respondent's opinion in answering to survey questionnaire;
- To tick (√) the respondent's choice at the rectangular shape in front of each proposed answer;
- To understand well the question before translating to respondents;
- To translate each question to respondents and give them time to answer before proceeding to the next question;
- To respectthe order of questions;
- To give enough time to respondents to answer questions

Section I: Questions on Household Demographic Characteristics

Q1. How old are you? ☐

Q2. What is yourgender? Male☐ Female☐

Q3. What is your education level?

Primary Education ☐ Secondary Education ☐ University ☐

Technical school ☐ No formal education ☐

Q4. What is the number of people in your household? ☐

Section II: Questions on Agroforestry Practices

Q5. What are the types of agroforestry practices applied on your farm?

Intercropping ☐ Alley cropping ☐ Scattered trees on a farm ☐

Contour hedgerows ☐ Fodder banks ☐ Woodlots ☐ Windbreaks ☐

Living fence ☐ Protein banks ☐ Shelterbelts ☐ Home gardens ☐

Q6. What is the number of agroforestry practices applied on your farm? ☐

Section III: Questions on Agroforestry Inputs

Q7. What are the types of agroforestry inputs used on your farm?

Organic fertilizer ☐ Long term tree seeds ☐ Short term tree seeds ☐

Agroforestry fruit seeds ☐ Soil cover plant seeds ☐ Green manure ☐

Improved seeds ☐ Improved livestock breeds ☐ Traditional crops ☐

Q8. What is the number of agroforestry inputs applied on your farm? ☐

Q9. What is the quantity of organic fertilizer applied on your farm every year? ☐

Q10. What is the quantity of improved seeds applied to your farm every year? ☐

Q11. What is the number of livestock heads held on your farm? ☐

Section IV: Questions on Agroforestry Land Size

Q12. What is the size of your farm in Hectare? ☐

Q13. What is the area (in Hectare) under agroforestry on your farm? ☐

Section V: Questions on Agroforestry Income

Q14**.** What types of agroforestry products do you sell from your farm?

Trees poles ☐ Timber ☐ Firewood ☐ Crops ☐

Stakes for crops ☐ Fodder for livestock ☐ Mulch ☐ Livestock ☐

Fruits ☐ Leasing livestock ☐ Honey ☐ Vegetables ☐

Q15**.** How much income do you earn by selling agroforestry products from your farm per year? ☐

Q16**.** How much income do you save by utilizing agroforestry products from your farm per year? ☐

Section VI: Questions On Subjective Wellbeing

Q17. Has the agroforestry practice assisted you in any of the following aspects of your wellbeing? If so, rate the assistance on a scale of 0 (not assisted) to 10 (highly assisted).

1. **Improved your standard of living (Material Provision)**

Food: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

Shelter: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

Clothing: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

Capital: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

Assets: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

2. **Assisted in your health (Good Health)**

Provision of health services: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

Cost of health services: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

3. **Assisted in your spiritual fulfillment (Spirituality/Religiosity)**

Belief in God: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

Attendance to worship areas (Church, Mosque, Holy place): (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

4. **Assisted you in controlling the state of your environment**

Ability to control political situations: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

Ability to acquire resources: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

Ability to acquire skills: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

Ability to acquire knowledge: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

Ability to acquire information: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

5. **Emotions and affiliations**

Respect: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

6. **Community connectedness**

Part of community: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

Social obligations: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

Listen to: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

Receive help: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

7. **Future security**

Feel secured: (not assisted) 0 1 2 3 4 5 6 7 8 9 10 (highly assisted)

Appendix B: Field Photos of Agroforestry Practices

Intercropping of Banana and Grevillea on agroforestry farm of Venant Kanyamugara, Gikomero Sector, Gasabo District. *Source:* Jean Luc Mutagoma, 2021

Alley cropping of Calliandra and Banana on agroforestry farm of Venant Kanyamugara, Gikomero Sector, Gasabo District. *Source:* Jean Luc Mutagoma, 2021

Contour hedgerow of Jacaranda and Banana on agroforestry farm of Mukabagorora Stephanie, Nduba Sector, Gasabo District, Rwanda. *Source:* Jean Luc Mutagoma, 2021

Live fence of Calliandra on agroforestry Mukabagorora Stephanie, Nduba Sector, Gasabo District. *Source:* Jean Luc Mutagoma, 2021

Intercropping of Calliandra, Napier grass, and Banana on agroforestry farm of Ruzindana Emmanuel, Nduba Sector, Gasabo District. *Source:* Jean Luc Mutagoma, 2021

Shelterbelt of Calliandra and Bees on agroforestry farm of Ruzindana Emmanuel, Nduba Sector, Gasabo District. *Source:* Jean Luc Mutagoma, 2021

Contour trees of Grevillea trees on the agroforestry farm of Kabera Innocent, Gikomero Sector, Gasabo District. *Source:* Jean Luc Mutagoma, 2021

A woodlot of Grevillea trees on the agroforestry farm of Kabera Innocent, Gikomero Sector, Gasabo District. *Source:* Jean Luc Mutagoma, 2021

The contour of Grevillea trees on agroforestry farm of Dusabimana Eugene, Gikomero Sector, Gasabo District. *Source:* Jean Luc Mutagoma, 2021

The contour of Grevillea trees on agroforestry farm of Dusabimana Eugene, Gikomero Sector, Gasabo District. *Source:* Jean Luc Mutagoma, 2021

Appendix C: Table of Descriptive Statistics Indices of Domains Used to Compute the Subjective Wellbeing Index

Domains	Mean	Median	Mode	Std. Dev.	Range
Standard of living	**6.55**	**6.80**	**7.00**	**2.07**	**15**
Food	7.55	8.00	8.00	1.82	7
Shelter	6.51	7.00	7.00	2.23	9
Clothing	6.83	7.00	8.00	3.66	53
Capital	5.78	6.00	7.00	2.52	10
Assets	6.07	6.00	8.00	2.69	10
Health status	**8.97**	**10.00**	**10.00**	**1.72**	**10**
Provision of health services	8.94	10.00	10.00	2.12	10
Cost of health services	9.01	10.00	10.00	1.70	9
Spirituality/Religiosity	**8.12**	**8.50**	**10.00**	**1.98**	**9**
Belief in God	8.53	9.00	10.00	1.94	9
Attendance to worship areas	7.71	9.00	10.00	2.51	9
Quality of environment	**6.62**	**6.60**	**6.40**	**1.66**	**8**
Ability to control political situations	6.28	6.00	6.00	2.28	9
Ability to acquire resources	6.38	6.00	6.00	1.99	9
Ability to acquire skills	6.93	7.00	8.00	1.94	9
Ability to acquire knowledge	6.54	6.50	5.00	1.90	8
Ability to acquire information	6.97	7.00	8.00	1.90	8
Emotions and affiliations	**7.34**	**8.00**	**8.00**	**2.09**	**9**

Community connectedness	**6.20**	**6.00**	**5.25**	**1.84**	**9**
Part of community	6.84	7.00	9.00	2.15	9
Social obligations	6.03	6.00	5.00	2.02	9
Listen to	6.60	7.00	6.00	2.14	9
Receive help	5.32	5.00	5.00	2.42	10
Future security	**7.80**	**8.00**	**10.00**	**1.91**	**8**
Subjective Wellbeing Index	**7.00**	**7.00**	**7.00**	**1.51**	**8**

Appendix D: ANU Letter of Ethical Approval

AFRICA NAZARENE
UNIVERSITY

1st September, 2021

RE: TO WHOM IT MAY CONCERN

Jean Luc Mutagoma (**19M01DMEV010**) is a bonafide student at Africa Nazarene University, in the Environment and Natural Resource Department. He has finished his course work and has defended his thesis proposal entitled: - ***"Assessment of the Influence of Agro forestry Practices on the Subjective Wellbeing of Households in Nduba and Gikomero Sectors of Gasabo District, Rwanda".***

Any assistance accorded to him to facilitate data collection and finish his thesis is highly welcomed.

Rodney 2. Reed

Prof. Rodney Reed
Deputy Vice Chancellor, Academic & Student Affairs Office

Appendix E: Zamuka Cooperative Letter of Research Permission

ZAMUKA COOPERATIVE

GASABO DISTRICT

5th September 2021

RE: Permission for Conducting Research

Dear Jean Luc,

I am pleased to inform your request for collecting data for research from ZAMUKA Cooperative farmers as part of the completion of your master thesis entitled: "Influence of agroforestry practices on the subjective wellbeing of households in Nduba and Gikomero Sectors of Gasabo District, Rwanda.

ZAMUKA appreciates your research and is willing to support you in this important academic work. Please work closely with staff for further assistance.

We wish you all the best in your research.

Yours sincerely,

Eraste Habimana,

ZAMUKA Cooperative President

Office Location: Nduba Sector, Gasanze Cell, Nyabitare Village
Contacts: ZAMUKA Manager: +250784339716/ ZAMUKA Chairperson: +250788622097
E-mail: zamukacoop@yahoo.fr **Street Avenue:** Opposite Kami Barracks

Appendix F: Consent Letter

Jean Luc Mutagoma
Gasabo District
Kigali-Rwanda
Date: … / … / 2021

To: ……..…….(Name of the respondent)

RE: Request for your consent to participate in the study

I hereby write this letter requesting your permission to participate in the study entitled: "Assessing influence of agroforestry practices on the subjective wellbeing of households in Nduba and Gikomero sectors of Gikomero district, Rwanda." by responding to the survey questionnaire.

My name is Mutagoma Jean Luc, I am a graduate student in Environment and Natural Resources Management at Africa Nazarene University, Kenya. As part of the completion of my master thesis, I am collecting information that will help me to study the influence of agroforestry practices on households' subjective wellbeing of households in Nduba and Gikomero sectors of Gasabo district. If you allow me to get this important information, I ensure you that the information you provide will be treated with confidentiality, and your name will not be identified anywhere in the report that will be compiled. The interview will take about one hour, and I will try to ensure that it does not interfere with your normal work.

I look forward to your participation.

Sincerely yours,