

**ADOPTION OF BANANA VALUE ADDITION AND ITS EFFECT ON
PROFITABILITY OF SMALL-SCALE AGRI-ENTERPRISES IN KISII COUNTY,
KENYA**

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**A Thesis Submitted to the Graduate School in Partial Fulfilment of the Requirements
for the Master of Science Degree in Agri-Enterprise Development of Egerton University**

EGERTON UNIVERSITY

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented in this University or any other for the award of a degree.

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DEDICATION

I dedicate this work to my beloved parents, siblings, baby Emmanuel, Prof. Ogendi, the Director of Graduate School, Egerton University and Mr. Nathan, the director of Agriculture, Kisii County.

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ABSTRACT

Value addition in the banana value chain has become an important opportunity especially the time of high postharvest losses. The strategy prolongs and improves the shelf life and quality of banana fruit hence increasing agripreneurs' profits. Despite this documented benefits, adoption of banana value addition has remained low globally. This study sought to determine the adoption of banana value addition and evaluate its effects on profitability in Kisii County, Kenya. The specific objectives were: (i) To characterize adopters and non-adopters of value addition among small-scale banana agripreneurs in Kisii County (ii) To examine the factors influencing adoption of banana value addition among small-scale agripreneurs in Kisii County (iii) To evaluate the effect of adoption of banana value addition on profitability among small-scale banana agri-enterprises in Kisii County. The study used pre-tested semi-structured questionnaire to collect cross-sectional primary data from 201 agripreneurs selected using mult-stage sampling technique in Kisii County, Kenya. Descriptive analysis, Cragg's double hurdle and propensity score matching approach was used to analyse objective one, two and three respectively. Descriptive statistics indicated that flour milling was the most adopted value addition activity followed by slicing and drying, sorting and grading and finally crisps making. Chi-square and t-test results revealed that significant differences between adopters and non-adopters were observed in extension contacts, trainings received, type of road, primary occupation, age, group membership, distance to the output market, output produced, and farm size. Moreover, double hurdle model summarized that output produced, primary occupation, use of murram roads, number of trainings and extension visits, distance to output market, and group membership had a significant effect on decision to adopt banana value addition. While access to credit, use of tarmac roads, output produced, farming experience, number of extension visits, and marital status had a significant effect on extent of adoption of banana value addition. Finally, findings revealed that adoption of banana value addition has a positive significant effect on profitability. Adopters increased their profits by KES 45,510.72 per acre. There is need for the public and private agricultural extension organizations to provide more trainings and extension services to agripreneurs. The County government and development organizations should sensitize agripreneurs to form groups and cooperatives to enhance working collectively in production, processing and marketing of bananas and its value-added products. The County government should invest more funds on developing rural roads to improve access of markets among agripreneurs. All these enhance adoption of banana value addition.

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LIST OF ABBREVIATIONS AND ACRONYMS

ASTGS	Agricultural Sector Transformation and Growth Strategy
ATC	Agricultural Training Centre
ATT	Average Treatment Effect on the Treated
ATU	Average Treatment Effect on the Untreated
BVA	Banana Value Addition
CIDP	County Integrated Development Plan
DHM	Double Hurdle Model
EUT	Expected Utility Theory
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
HCD	Horticulture Crops Directorate
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KARLO	Kenya Agricultural Research and Livestock Organization
KES	Kenyan Shillings
KIRDI	Kenya Industrial Research and Development Institute
KYAS	Kenya Youth Agribusiness Strategy
NAS	National Agribusiness Strategy
NACOSTI	National Commission for Science Technology and Innovation
NBP	Nyangorora Banana Processors
PSM	Propensity Score Matching
RUT	Random Utility Theory
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
UoN-WEE	University of Nairobi-Women's Economic Empowerment

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Agriculture in Kenya has remained the key for improving economic growth, promoting food security, poverty alleviation and rural development (Kwizerimana *et al.*, 2023). However, farming and food systems are under pressure while agricultural productivity and economic returns are declining (Omari *et al.*, 2024). Moreover, poverty levels have been on the rise due to decreasing cultivable land threatened by increasing population (Omari *et al.*, 2024). This has led to rise in demand for food and raw materials for industries (Mwangi & Kariuki, 2015). This has triggered much of attentions on the need to promote sustainable agriculture associated with increased productivity and economic returns through adoption of agricultural innovations and value addition technologies to meet the growing demand for food (Mwangi & Kariuki, 2015).

Banana (*Musa paradisiaca Linn*) is among the horticultural crops produced for domestic and commercial use (Kwizerimana *et al.*, 2023). It's grown over 130 countries globally in tropical and subtropical regions (Easwari & Maruthupandi, 2020). The global production of bananas stands at 105.3 million metric tons per year (Food and Agricultural Organization - FAO, 2020a) and it has increased by about 150% in the last three decades (Evans *et al.*, 2020). Furthermore, the consumption of bananas is expected to rise with the growing population (Sugianti *et al.*, 2022). Globally, India which produces approximately 27.63 million metric tons per year is the leading producer of bananas followed by China, and Indonesia (FAO, 2021a).

In the world, bananas are sources of starch, ranked third after cassava and sweet potatoes and a fourth largely cultivated crop after rice, wheat and maize (Momanyi *et al.*, 2021). In Kenya, its grown by smallholder agripreneurs who own less than 0.3 hectares. Agripreneurs grow both local and improved varieties with both dessert and cooking types (Omondi *et al.*, 2020). Population pressure and change of consumption behaviours has provided a good opportunity to increase banana production (Nyang'au *et al.*, 2021). Bannas are grown in Meru, Kirinyaga, Embu, Taita Taveta, Muranga, Tharaka Nithi, Kisii, Bungoma, Kakamega, Nyamira, Migori and Homa Bay Counties (Ministry of Agriculture, Livestock and Fisheries - MoALF, 2017). In Kisii County, bananas are among those crops that are consumed domestically and used to bring cash to agripreneurs (Wahome *et al.*, 2023). The county earns over 70% of earnings from fresh and ripe bananas (Momanyi *et al.*, 2021).

Banana is a multipurpose crop. It is applied in industries and used as a food and feed for livestock (Rono *et al.*, 2022). It is rich in carbohydrates, minerals, vitamins among others (Wahome *et al.*, 2021). It provides more than 25% of carbohydrates and 10% of calorie intake to more than 70 million people (Omari *et al.*, 2024). It is eaten fresh, cooked or in processed forms such as chips, dried fruit, bread, ice cream, smoothie, juice (Al-Dairi *et al.*, 2023). Banana flour can also be mixed with legume-based products to make baby foods and other snacks (Al-Dairi *et al.*, 2023). Despite the health and economic benefits of bananas in the economy, agripreneurs along the value chain are constrained by numerous challenges which act as disincentives including postharvest losses, inadequate access to markets and fluctuating prices (Wahome *et al.*, 2023). These problems limit agripreneurs from maximizing profits hence minimal incomes are earned.

The later mentioned challenges, together with high transport and labour cost have affected banana production (Momanyi *et al.*, 2021). Addressing these problems, small-scale agripreneurs have embraced some strategies such as use of hexanal technologies, cold storage facilities and 1-methylcyclopropane (Kahwai *et al.*, 2021). However, in Kenya postharvest losses along the banana value chain are still high estimated at 30-40%. Moreover, in India, postharvest losses stand at 40-50% attributed to improper handling, transportation, marketing and processing (Subbaiah *et al.*, 2018). Moreover, banana yields remain low in Kenya despite agripreneurs adopting improved varieties. For instance, yields are estimated to be 4 to 15 tonnes per hectare per year which is far much below its potential of 30 to 40 tonnes per hectare per year realized under good agronomic practices (Faria, 2015; Mungai *et al.*, 2015).

Additionally, in Kenya, especially Kisii County, 20% of the fresh bananas are lost during transportation and 30% due to inadequate storage facilities (Ntinyari *et al.*, 2017). Moreover, most of the banana agripreneurs in Kisii and Meru Counties sell fresh fruits to neighbours and local traders including middlemen at giveaway prices due to inadequate access to better markets (Gebre *et al.*, 2022; Wahome *et al.*, 2021). Banana value addition activities has become worth to address the following challenges along the banana value chain including post-harvest losses, inadequate market accessibility and low prices. Bananas are often eaten fresh, however, processing them into dried chips, flour, crisps among others reduces wastage as well as bulkiness, hence easy transportation to the market (Muigai *et al.*, 2021). In agriculture, value addition entails any practice carried out by small-scale agripreneurs or firms to improve storage of perishable products, minimize the rate of postharvest losses, increase market demand as well as profitability (Bosompen *et al.*, 2024). In the context of banana, it

means changing the original state of fresh fruit or characteristics to a more valuable form either through cleaning, sorting and grading, or processing it into dried chips, flour, crisps, jelly, jam, or baked products (Ibrahim *et al.*, 2020).

Value addition globally has gained recognition from various stakeholders due to its great benefits attached to it (Abong' *et al.*, 2016). In Kenya, through projects, the governments, NGOs, and other private sectors have considerably promoted value addition as a strategy to reduce postharvest losses and increase agricultural productivity which improves food security, enhance rural livelihoods and promote sustainable agricultural practices (Munyao, 2020; Owiti, 2023). The motivation behind adding value to banana fruit by small-scale agripreneurs is to increase profitability (Chacky & Pande, 2022). Banana value addition reduces post-harvest losses while extending the shelf life of products, improving quality and quantity of fresh bananas allowing for better price stabilization through product diversification (Schiasi *et al.*, 2018). Banana agripreneurs also benefit from accessing better markets associated with higher prices on value added products while maximizing their profits which improves their economic resilience (Alalade *et al.*, 2019).

Globally, some potential banana growing regions have adopted numerous value addition activities. In India the bananas are processed into fried chips, pulp, wafers, and powder. However, only 5% of bananas produced are used in processing while 95% are domestically consumed (Dhake *et al.*, 2019). In Uganda, bananas are roasted and fermented into juice and wine (Alex *et al.*, 2015). In Tanzania, Rwanda and Burundi, bananas are processed into local beer for domestic use (Kubo & Kilasara, 2016). In Kenya especially Murang'a County, bananas are processed into banana jam, wine, crisps, and flour to a small extent. Kiburi food processors in central region of Kenya are drying bananas using solar dryers. In Meru and Tharaka Nithi counties banana agripreneurs are producing dried chips, jam, flour and crisps in small-scale (Rono *et al.*, 2022). However, all these are done in small-scale and for domestic use.

In Nyeri county, the agripreneurs are involved in ripening, sorting, flour milling, and packaging (Rono *et al.*, 2022). In Kisii County, some agripreneurs are producing flour, bread, crisps and hypertension medicine for domestic and commercial use (Obaga & Mwaura, 2018). Others are highly involved in commercial flour milling and other baked products (*mandazi and chapatti*) for home consumption (Marube, 2017). Despite the potential benefits of banana value addition, inadequate finance, technical experts, limited information on value addition, weak

extension services and high cost of processing equipment pose a great challenge to adoption of banana value addition among agripreneurs (Agoh, 2021; Hinai *et al.*, 2022).

In Kenya, value addition has been given attention by universities through projects such as University of Nairobi-Women's Economic Empowerment (UNWEE). At Kisii County, the government has come up with strategies and various developmental programs and projects to promote banana value addition. Through the national government, the County government has taken initiatives to train the agripreneurs on various banana value addition activities using KIRDI machines. Moreover, some have been supported with the dehydrators and solar dryers (Farmbiz Africa, 2022). However, adoption of banana value addition in the county has remained low. Information on factors influencing adoption of banana value addition and its effect on profitability will act as a guide to governments, agripreneurs, policy makers, extension officers and other stakeholders to put in place initiatives to promote banana value addition in their quest to increase profitability hence improving their well-being. Therefore, this study sought to investigate the factors that influence adoption of banana value addition and evaluate effects of value addition on profitability in Kisii County, Kenya.

1.2 The statement of the problem

Banana farming plays an important role in economic development to most rural households in Kisii County. This is because, banana is a source of livelihood to small-scale agripreneurs engaged in production and marketing of banana and its products. However, agripreneurs are constrained by postharvest losses, inadequate access to markets and fluctuating prices. These challenges have limited agripreneurs from maximizing profits from bananas. Previously, the Kenyan government and development partners have designed interventions such as promotion of value addition aimed at addressing these challenges while improving profitability. Despite these efforts, adoption of banana value addition in Kisii County, has remained low. Previous studies on determinants of banana value addition have focused more on gender, cropping systems, extension services, access to credit, farming experience, and group membership. However, information on factors influencing adoption of banana value addition and its effect on profitability, remains scanty. Therefore, this study sought to determine factors influencing adoption of banana value addition and its effect on profitability among small-scale agripreneurs in Kisii County, Kenya.

1.3 Research objectives

1.3.1 General objective

To contribute toward increased profitability of banana agri-enterprises for improved livelihoods through enhanced adoption of banana value addition among small-scale agripreneurs in Kisii County, Kenya.

1.3.2 Specific objectives

- i. To characterize adopters and non-adopters of value addition among small-scale banana agripreneurs in Kisii County, Kenya
- ii. To determine the factors influencing adoption of banana value addition among small-scale agri-enterprises in Kisii County, Kenya.
- iii. To evaluate the effect of adoption of banana value addition on profitability of small-scale banana agri-enterprises in Kisii County, Kenya.

1.4 Research questions

- i. What are the social-economic and institutional characteristics of adopters and non-adopters of value addition among small-scale banana agripreneurs in Kisii County Kenya?
- ii. What are the factors influencing adoption of banana value addition among small-scale agri-enterprises in Kisii County, Kenya?
- iii. What is the effect of adoption of banana value addition on profitability of small-scale banana agri-enterprises in Kisii County, Kenya?

1.5 Justification of the study

Bananas like other crops has multiple uses among rural and urban population in Kenya. It is a source of food and nutrition security, raw materials for industries and livestock feed. To increase its quality and quantity as well as economic value, value addition activities along the banana value chain have been promoted by government and development partners. Value addition has enabled agripreneurs to tap into new markets associated with higher prices leading to higher profit margins which boosts the income from banana fruit. Value addition has also promoted rural development by providing job opportunities to people in processing facilities and supporting local economy.

Value addition is one way of improving profitability among small-scale agripreneurs with diversifying agricultural products. This enable subsistence agriculture to be transformed into a commercial sector. This contributes to promotion of food security and poverty alleviation. This study therefore, contributes to attainment of Sustainable Development Goals (SDGS) of 1 no poverty, 2 zero hunger, 8 decent work and economic growth and 13 climate action, Kenya's Agricultural Sector Transformation and Growth Strategy (ASTGS 2019-2029), Kenya Vision 2030, Bottom -Up economy and Kisii CIDP (2022-2027).

The study will provide insights for policy makers to design policy programmes to promote banana value addition in the county. The findings are also important t extension service providers, government and development partners to develop value addition related projects to create its awareness and preference among agripreneurs. The findings also contribute to a body of knowledge. It is used as a reference by researchers who may have the interest in the same or related topic of study.

1.6 Scope and limitation of the study

The study was carried out in Kisii County. It was limited to sorting and grading, slicing and drying, flour milling and frying into crisps as banana value addition activities. This study was restricted to agripreneurs who's major agri-enterprise was bananas. The researcher depended on agripreneurs 'ability to recall the information due to poorly kept records. However, probing technique was used to improve the accuracy of the data. The findings could be generalised in other potential banana growing regions in Kenya.

1.7 Operation definition of terms

Adoption: Decision to use a technology such as banana value addition

Agri-enterprise: Activities in the banana value chain involving production and marketing

Agri-preneur: A farmer trying to embrace commercial banana farming

Banana value addition – Processing banana to other products or adding some value while maintaining its original form

Gross Margin: This is the difference between the gross revenue and total variable cost of banana fruit and its value-added products

Profitability: Ability of banana agripreneur to generate more revenue than costs. The difference is called profits which is obtained through gross margin analysis.

Small-scale: A farmer growing banana in small piece of land less than 3 acres

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature on value addition in agriculture, its trends, challenges and policies in existence to encourage its adoption. Second, it presents a review on banana value addition globally and in Kenya, its challenges and policies put in place to encourage banana value addition. Third, it gives a discussion on adoption of value addition factors and its impact on income. Forth, it explains the conceptual and theoretical framework of the study. lastly, it gives summary of literature and identified gaps.

2.2 Value addition in agriculture globally

Agriculture has remained the primary source of livelihoods to most rural populations in Sub-Saharan countries. In Africa, it supports 70% of the rural people, however, the key hindrances to most farmers, is inadequate utilization of agricultural technologies including value addition (Chacky & Pande, 2022). There is increasing tendency of value-added products in the international markets (Gashaw *et al.*, 2018). High-income countries add about US \$185 of value by processing one ton of agricultural products, while developing countries add approximately US \$40. Furthermore, while 98 % of agricultural production in developed countries undergoes industrial processing, just about 38 % is processed in developing countries (Gashaw *et al.*, 2018). This show that, developing countries are still constrained with the resources and value addition potential is yet to be exploited compared to high-income countries.

In the agricultural sector, most agricultural commodities are perishable. Some studies argue that farm losses as a result of postharvest mishandling is approximately 30-40% and is increasing (Basompem *et al.*, 2024). Therefore, there is a need to add value to minimise the losses. Urbanization has increased the demand for food crops hence enhancing the production of various value-added products, such as bread, biscuits, noodles, cakes, baby foods and sweeteners especially in the cassava industry (Falola *et al.*, 2016). In Nigeria, research centres have developed and deployed agricultural technologies to farmers including casava value addition. cassava tubers are processed into chips, pellets, flour, alcohol and starch among farmers to increase farm level incomes (Onyedikachi & Delight, 2016).

India has a high production of coconut every year. However, over 40% of the total nuts produced are consumed either fresh or tender nuts and about 50% of the nuts are transformed

into copra which are eaten as coconut meal and oil. A little is consumed as desiccated coconut and other products. This gives evidence that there is underutilization of coconut as value added products. Challenges included high production cost, and nonremunerative markets (Gopan & Manjunath, 2022; Mannekote & Kailas, 2016).

Melembe *et al.* (2020) conducted a study on patterns of smallholder farmers' choice of value addition in South Africa. The study reported that most smallholder farmers have inadequate access to better markets which are associated with low portions of output harvested and low-quality products. The commonly practiced activities include: washing and abattoir, while fortification, labelling, drying and canning were adopted to small extent.

In Northern Ghana, the local shea business is a vibrant source of income to rural women besides farming. Over many years, shea butter has been commercialized internationally, as margarine and chocolate and applied in cosmetics industry. However, the women have not fully utilised the potential benefits of shea trees. As a result of these, the government of Ghana has put in place strategies to promote shea industry. For instance: Community Life Improvement Programme (CLIP) was established to render community level services in food security, water supply and micro-credit.

In Uganda, shea nuts are underutilized during value addition. the processers sell the nuts with little value addition. they can decide to have it low or process some of it (Akatwetaba *et al.*,2023). Mamo *et al.* (2014) revealed that smallholder dairy farmers are traditionally processing sour milk into local cheese and butter. However, these methods are tiresome and unhygienic which provides high chances for milk contamination. The study recommended provision of modern and sustainable processing machines to increase production of milk and its products.

Amadi (2018) reported that national and international research centres have developed cassava value added technologies in Nigeria. These technologies have diffused to smallholder rural farmers who have also been trained by these research centres. Cassava is processed into *garri*, cassava chips and high-quality cassava flour by smallholders however, female farmers are limited on value addition by inadequate access to credit, cooperative and difficult in decision making.

In Ethiopia, small-holder coffee farmers are facing hindrances in converting the red cherries into dry cherries due to improper post-harvest processing and handling practices such as drying on bare ground, rainy weather particularly during drying season, improper storage and transportation since income of smallholder farmers in the coffee sub-sector has remained

low (Gashaw *et al.*, 2018). Maku *et al.* (2023) reported that value chain development for agricultural commodities including maize should be conducted to enable the youth participate in value addition. Togarepi *et al.* (2015) The study concluded that with improved production of agricultural output through provision of subsidised inputs including fertilisers and seeds would create opportunities for value addition in Namibia.

Jaravaza and Isaac (2015) in Zimbabwe has shown that government as well as farmers have advocated strategies to promote commercial oriented agriculture thorough value addition. The main value addition undertaken to a small extent include; bagging of mainly maize and ground nuts, bottling of peanut butter after processing, chilling of milk, drying of excess vegetables, curing of tobacco and grinding of maize. However, lack of capital and technical knowledge and skills were found to be the major hindrances among farmers. Therefore, trainings should be provided to enhance value addition adoption

Kenya is ranked among the top ten largest economies and the middle-income country in Africa. Joint efforts have enabled dissemination and development of value addition technologies. They include: Kenya Tea Development Authority (KTDA), Arid Lands Resource Management Project (ALRMP), Kenya Agriculture Livestock and Research Organisation (KALRO), Kenya Agricultural Productivity Programme (KAPP), Eastern Province Horticulture and Traditional Food Crops Project (EPHTFCP) (Ntale *et al.*, 2014).

Research conducted on Mango processing and marketing in Kenya and Germany reported that mango value chain is constrained by high post-harvest losses because of poor market access, inadequate storage technologies and processing facilities. Therefore, processing mango fruit through solar drying, can increase shelf life and enable smallholder farmers access new markets, diversifying income and livelihoods. However, processing activities of both indigenous and grafted mango fruits are not such common among farmers and other industrial farms (Mujuka *et al.*, 2021).

In Kenya for instance, 90% of fruits and vegetables are sold as raw produce in informal markets (Chemeltorit *et al.*, 2018). This shows low level of value addition being embraced. Oluoch *et al.* (2016) and Orinda *et al.* (2017) showed that in Homa-Bay County Sweet potatoes are processed into flour, baking breads, buns, cookies, muffins cakes and doughnuts, *chapatti*, *mandazi*, crisps, others through steaming, boiling or roasting the raw tubers. However, inadequate product development, proper packaging and labelling have limited smallholders in value addition. Machakos County, mangoes are processed into mango juices, dessert, sliced and packed mangoes. Mango can also be value added into sliced and dried mangoes, mango

powder, mango wine among others however, farmers have not adopted them because they require more advanced processing technologies which are costly. (Musyoka *et al.*, 2020).

Kitui and Taita Taveta Counties are producing huge quantities of guavas although processing remains extremely low due to little knowledge and skills in processing and inadequacy of appropriate equipment (Omayio *et al.*, 2020). In Kenya, production of cassava is Plenty. It is processed into flour which is the most common meal in coastal regions while dried chips are mainly produced in Migori and Busia counties. However, inadequacy of value addition and processing equipment, trainings, extension service and education remain hindrances (Awuor *et al.*, 2018).

2.3 Banana value addition globally

Bananas does well in tropical and sub-tropical areas. A part from consuming raw bananas, it is converted into other products through processing and other traditional methods like ripening. However, low value addition of banana has been experienced in most parts of the countries globally. In Asia, the banana farmers have not potentially utilised the health and economic benefits of bananas. This low uptake of new technologies could have been led by inadequate technical knowledge on value addition technologies, poor infrastructure and lack of policies that supports adoption of technologies in agribusiness sector (Muigai *et al.*, 2021).

In India, smallholders have exploited lucrative markets and obtained shares in marketing along the value chains. However, value addition of bananas has remained low (Subbaiah *et al.*, 2018). Banana processed products are gaining popularity in world markets due to its nutritional and economic value to agripreneurs. 17 products can be processed from banana fruit however, about 5% is subjected to value addition (Dhake *et al.*, 2019).

In Africa and Central America, there exist limited resources to boost banana value addition. However, Banana can be processed into various products such as; biscuits, sweets, crisps, cakes, jam, sauce and yoghurt that are more edible. This needs joint efforts by both public and private sectors, including investing together, credit lines and tax breaks (Tinzaara *et al.*, 2018). Banana peels are used to make flour which is used as phyto-chemicals and antioxidant. banana peels in industries can be used to make include: vinegar and alcohol (Dhake *et al.*, 2019). In Nigeria, bananas are used to make flour which is mixed with wheat flour to make bread, meat pies, chin-chin, pancakes and other snacks (Adeniji *et al.*, 2010).

The proper way to dispose the surplus perishable produce including bananas is through value addition (Muigai *et al.*, 2021). The study reported that in Chuka Sub-County Kenya,

39.1% of sampled smallholder farmers embraced banana value addition with some taking part in banana ripening for sale (35.6%) and bulk packaging (64.4%) respectively. Adoption of advanced forms of banana farming is at a zero rate. Moreover, ripening is not enough for farmers to yield substantial income from bananas since this could not prevent post-harvest losses at all.

Kirimi *et al.* (2021) conducted a study on extension training for banana value addition among smallholder farmers in Meru and Tharaka-Nithi counties, Kenya. The study reported that although the farmers were trained on various forms of banana value addition and became aware, utilization of various banana value added products has remained inadequate. (Bonabana-wabbi *et al.*, 2015). The findings have shown that trainings are not enough to enhance the adoption of these technologies among farmers. Thus, there is a need to create awareness through provision of capacity building to farmers on access and transfer of value addition technologies to improve their livelihoods (Kirimi *et al.*, 2021).

Mbuthia *et al.* (2018) reported that Meru County produce huge quantities of bananas which are sold locally and nationally. Through the Meru Banana Farmers' Cooperative (MBFC) during the year 2014, it helped farmers to supply bananas to supermarkets. However, there supply was not consistency. Farmers are producing banana juice and snacks in small extent. Although farmers were trained by Jomo Kenyatta University of Agriculture and Technology (JKUAT) on value addition, still its utilization has remained low (Mbuthia *et al.*, 2018).

Nyeri county is among the banana growing regions in Kenya. There are a number of banana value addition activities being carried out by the smallholder farmers to improve their incomes. For instance: ripening, sorting, flour making and packaging. These farmers are using a normal way in ripening and sorting the bananas by use of human labour. While flour making is done using the solar energy to dry the bananas. However, there is no sustainable source of energy to dry the bananas (Rono *et al.*, 2022).

In Tharaka Nithi County, small-holder banana farmers are involved in ripening, sorting, grading, flour making and packaging as the forms of banana value addition. Farmers are also involved in making of biogas, crisps, jam, ripening and general value addition (6.7%). In addition, farmers preferred drying and cooling as the best methods for bananas preservation. However, there is no sustainable source of energy for drying bananas (Rono *et al.*, 2022).

Muthee *et al.* (2019) concluded that farmers in Embu County sold their bananas in raw or ripened forms without any value addition. This imply that in Embu County farmers have not

yet embraced any value addition activity. Hence, there is a need to put in place mechanisms to introduce banana value addition strategies among the farmers to improve productivity and income which ultimately increase their livelihoods. In Kiambu County, smallholder farmers practice banana farming with little value addition estimated at 6%. Further, smallholder farmers in Chuka Sub County, Kenya, only 31.9% were involved in banana value addition especially flour milling (Muigai *et al.*, 2020).

In Kisii County, banana is consumed either as fruit, cooked or processed into other edible products (banana crisps, chips, jelly, jam, juice, sauce, puree, baked products such as cakes, bans, *chapati*, *mandazi*, and scones. However, most of these products have not been potentially commercialized even in the local markets (Mengstu *et al.*, 2021). Banana farmers are experienced by lack of storage facilities which has led to banana wastage (Obaga & Mwaura, 2018).

2.4 Factors influencing adoption of value addition

Existing studies show a set of factors affecting uptake of agricultural technologies. For instance, Musyoka *et al.* (2020) used Two Stage Heckman model to analyse factors influencing uptake of mango value addition. The findings revealed that off-farm income, access to cold storage facilities, price of value-added products, group membership, extension contact, amount of credit and hired labour positively influenced mango farm-level value addition. Training, farmers' awareness and access to cold storage facilities positively influenced the proportion of mangoes value added at farm-level, while distance to market had a negative effect on the proportion of mangoes value added. This was similar to Bundi *et al.* (2020).

Agwu *et al.* (2015) indicated that, gender, education, income, household size and output were statistically significant at different levels of probability. The study recommended the government and its agencies to encourage women to participate in cassava value addition and make high yielding cassava varieties available to them

Maku *et al.* (2022) discussed that education, land size, credit access, age, access to training affected maize value addition positively at 1% significant level while extension services, rural location and market access negatively influenced value addition at 1% significant levels. The study concluded that trainings should be organised among youths and strategic business location to enhance participation in agricultural value chains.

Orinda *et al.* (2017) used Heckman two stage model to document factors affecting the decision to add value to sweet potatoes. The results indicated that probability of adoption was

negatively influenced by land size, household size, and credit access. While total quantity produced and trainings positively influenced the decision to add value. In addition, extent of value addition was positively and statistically affected by group membership, credit access, total quantity of sweet potato produced and distance to nearest output market. This was same as Oluoch *et al.* (2016) specifically on distance to the market.

Muigai *et al.* (2021) indicated that group membership and access to credit positively influenced the decision to adopt value addition. However, credit access can also be determined by firm size, ownership, strength of legal rights, and depth of credit information (Quartey *et al.*, 2017). Despite this fact, smallholder farmers have no collaterals to pay loans. Moreover, farmers may lack knowledge on how to use credit although they are able to access it (Muigai *et al.*, 2018).

Sebatta *et al.* (2015) documented that quantity harvested influenced the decision to add value to ware potato while access to extension services significantly and positively affected value addition to seed potato. Gashaw *et al.* (2018) and Sebatta *et al.* (2015), found the same findings like that of Musyoka *et al.* (2020) that agripreneurs are motivated by lucrative prices of value-added products and adopted value addition activities in coffee and potatoes respectively.

Small-scale agripreneurs/farmers have poor access to value addition information (Mujuka *et al.*, 2020). They are less exposed to emerging knowledge on value addition activities along the value chains they indulge in. One reason for this is limited access to value chain extension and advisory services (Dar *et al.*, 2021). The ratio of extension services providers to agripreneurs is limited, yet extension officers are less incentivized and motivated to disseminate information (Nyarko & Koza'ri, 2021). Further, these extension officers are limited in terms of multiple skills along the value chain, such that majority major in a single specific node in the value chain, especially the production side (Bahta *et al.*, 2021).

Mkandawire *et al.* (2018) indicated that location, project participation, type of farming enterprise, number of enterprises and gender composition significantly influenced the decision of farmers to engage in value addition. The study further recommended the Malawi government to set up developmental strategies that focuses more on value addition enterprises and support farmers to engage in those technologies.

Sarma *et al.* (2016)'s findings revealed that the decision of farmers to add value was positively and significantly influenced by household size, total value of assets and having a complementary business. While age of farmers, employment status, credit use, frequency of

slaughter and number of employees negatively and significantly influenced the decision to add value.

Adam *et al.* (2023) summarized that gender (female), membership to cooperative, access to credit facilities, farm size, and formal education positively and significantly influenced decision to add value while household size had a negative and significant influence on decision to add value. However, inadequate capital for business expansion, high cost of processing inputs, and preference for close substitutes such as wheat and semolina were found to limit the participation of cassava farmers in value addition.

Khoza *et al.* (2019) reported that off farm income, education, experience in farming, total livestock unit, land ownership, distance to agro-processing market, and access to agro-processing information influenced decision to participate in agricultural processing. While, education, Total livestock unit, trainings, producing grains, number of permanent labourers. Farm size, household size and age squared influenced the extent to add value. The study recommended for the set-up of cottage agro-processing industries to reduce transportation and storage costs

Amadi (2018) concluded that farm size, household size, age affordability and complexity of the technology among women farmers and age, education, farm size, farm income and membership of farmers association significantly influenced the decision to add value to cassava among male farmers respectively. However, inadequate readily organized markets for the products, processing equipment/facilities, knowledge of innovations and funds limited adoption of value addition among farmers. Therefore, easy and timely access of credit, markets and processing facilities should be provided to farmers.

2.5 Effect of value addition on profitability

Previous studies have used different indicators to measure the outcome of adoption of agricultural technologies in general. Value addition in particular, Obaga and Mwaura (2018) used household welfare, Jacob *et al.* (2023) and Wanyama *et al.* (2013) used household income and Oluoch *et al.* (2016) used farm income as an outcome variable. However, this study has used profitability as an outcome variable.

The study did not include income from other farm activities or other household sources of income such as employment or assets other income from non-farm activities. Profitability was measured using gross margin whereby only variable cost used in production of banana fruit and its product were included. (cost of manure and manure application, weeding,

harvesting, transportation, marketing, processing, labour, electricity, and storage). Nevertheless, costs on land preparation, banana suckers, depreciation on machineries or processing assets were counted as fixed cost. Thus, were excluded from the study.

Previous studies have indicated that value addition to agricultural commodities is among important practices that enhance the improvement of household livelihoods. However, Korir *et al.* (2020) noted that taking advantage of value addition potential, the subsequent activities should be competitive, sustainable and involve low-income rural farmers. It further increases agricultural productivity and raw materials for industries (Kano *et al.*, 2020).

Birachi *et al.* (2013) documented that farmers are able to get 50% more profits through collective marketing, and value addition of banana and Irish potato. Value addition also leads to increased shelf life of products which enhances market efficiency. As a result, transaction costs are cut down, others which are as a result of intermediaries. Korir *et al.* (2020) documented that sorting was found to be the most profitable value addition activity compared to frying, grading and chipping among the Irish potato farmers in Bomet County, Kenya. Therefore, the study recommended these farmers to put more efforts on adoption of sorting while looking for more cost-effective technologies (grading, chipping and frying).

Sebatta *et al.* (2015) concluded that both ware and seed potato farmers who were involved in value addition received 40% more profits than non-adopters. The findings prove that value added products fetch higher prices in the market by 30% more compared to raw potatoes which resulted to a price of UGX.1,200 per kilogram and UGX.150.00 per kilogram for value added products and raw potatoes respectively.

Issa and Chrysostome (2015) opined that farmers who were in cooperatives earned more incomes as a result of coffee processing such as; depulping, washing, and drying cherries. However, low production of secondary processed coffee beans characterized with low participation rates by agripreneurs in cooperatives was recorded. Low participation in value adding activities by primary agripreneurs (farmers) is common not only in coffee value chain but also in other agricultural value chains including banana value chain.

Wanyama *et al.* (2013)'s results explained that male and female farmers who added value obtained more incomes compared to non-value adders of both genders. For instance; female and male earned KES 69 and KES 29 respectively. Out by Oluoch *et al.* (2016) reported that farmers who added value received better income. Adoption of value addition led to formation farmer groups which enhance collective production, processing and marketing.

Agbarevo *et al.* (2015) explained that cassava value addition has created employment opportunities to micro and macro enterprises hence raising the socio-economic well-being of households. For instance; majority of women and youths in Nigeria have ventured into cassava enterprises others have been employed in agro-processing industries.

Omari (2015) mentioned that farmers who had access to on-farm storage facilities, increased their income more than farmers who did not have access to storage facilities. This finding was supported by Maganga *et al.* (2012) who found that adding value increased household incomes by 350%. Additionally, the results of Tweneboah Kodua *et al.* (2018) depicted that shea butter making was a profitable enterprise since it showed a positive significant effect on average values of gross margins, net incomes and net returns on investments in Ghana.

Jacob *et al.* (2023) used gross margin analysis to estimate the incomes of cassava farmers. It concluded that value addition adopters received more incomes than nonadopters. Hence, the study recommended that extension service agents be empowered to efficiently inform the farmers about value addition, easy access and use of credit and infrastructure to enhance production and value addition of cassava.

Tanzania is among the major producing countries of grapes world-wide. Chacky and Pande (2022) used the gross margin analysis to analyse the benefits. The findings revealed that smallholder farmers who add value to grapes get more profits compared to their counterpart. Omulo (2015) did an impact assessment on utilization of value addition of traditional vegetables in Lugari Kenya. The findings show that value addition of traditional vegetables has enabled women to commercialize their vegetables in high value markets and has meaningfully increased their income. Moreover, it has also enhanced their skills in farming through empowerment which has promoted food security and poverty reduction in the long run.

2.6 Summary of literature and identified gaps

Based on various recent studies reviewed on value addition in agriculture world-wide, it has been shown that agricultural sub-sectors are still constrained by higher post-harvest losses due to underutilization of value addition. Inadequate adoption of value addition is majorly attributed to inadequate processing equipment, lack of access to loans, lack of skills and experience on numerous processing activities due to inadequate capacity building through training, workshops, meetings seminars, agricultural shows, among others and finally poor infrastructure especially in rural areas.

Regarding the determinants of value addition, most studies have used binary models (logit or probit) to investigate the decision of participation. Further, some have used Heckman two stage model to determine proportion value added. However, these models have their own limitations. Therefore, this study adopted DH to determine the factors influencing adoption of banana value addition.

Several studies have discussed on advantages of value addition on different indicators including welfare of farmers, households, farm income, household income, profits among others. However, they give mixed results which could not apply to bananas. Some studies have also used linear models to evaluate the impact. Therefore, this study sought to use PSM to evaluate the effect of value addition on profitability.

2.7 Theoretical framework

There are two theories Random Utility Theory (RUT) and Expected Utility Theory (EUT) which guided the discrete choice models to model the decision to adopt and utilize a technology. These theories assume that given a set of alternatives, an agripreneur will choose an option on the alternative that gives maximum utility (Mercer, 2004). EUT is applied when the preferences are stated and choices are made in the presence of uncertainties and there is an expected outcome (Polak & Liu, 2006).

The agripreneurs are expected to measure the expected returns and costs from adoption of a banana value addition activity against the costs and benefits of not adopting it. An agripreneur adopts a banana value addition activity if the expected utility from adoption decision (U_a) is higher than the derived when one does not adopt (U_n) (Kassie *et al.*, 2015). RUT is used when preferences of the outcome are revealed and outcome decisions are made with no uncertainties. Utility is derived from underlying characteristics of a given value addition activity. Therefore, a value addition activity is described by its attributes that yields satisfaction to the small-scale agripreneur once adopted.

Adoption and use of value addition activity is treated as an outcome of optimization by different agripreneurs which happens due to availability of the activity, budget constraints and information asymmetry (Foster & Rosenzweig, 2010). RUT was applied to examine the determinants of adoption of banana value addition and its effect on profitability. It takes agripreneurs who are adopters as agents who make rational decisions to maximize utility in the presence of budget constraints, information asymmetry and technology availability RUT supposes that utility maximizing agripreneur will adopt a banana value addition technology if

the total benefits are more than zero (Gebre *et al.*,2023). RUT is specified in th equations below according to Malit *et al.* (2021).

$$A^* = A \text{ if } V_i > V_j \dots\dots\dots 1$$

$$A^* = A_j, \text{ if } V_i \leq V_j \dots\dots\dots 2$$

A_i , represent the banana value addition activity i while A_j , is an alternative banana value addition activity j. V_i and V_j are expected indirect utility values for value addition activity i and j respectively. A^* represent the banana value addition activity that is actually selected. The utility function is assumed to be known by each banana agripreneur even if some of its components are unobserved. The unobserved part of the utility is considered as random variable. The expected indirect utility is modelled as the sum of the observed variables and the non-observable random part.

$$V_i = \beta_i^1 X_i + \varepsilon_i \dots\dots\dots 3$$

The choice utility of implementing banana value addition activity can be written as;

$$V_j = \beta_j^1 X_j + \varepsilon_j \dots\dots\dots 4$$

β_i^1 and β_j^1 are vectors of the parameters. The banana agripreneurs can therefore decide simultaneously whether to select one or more BVA activity conditional on the vectors of the explanatory variables X_i and X_j . A double hurdle model can hence be used to analyse the agriprenuer’s joint decisions on selecting a value addition activity. From equations (3) and (4), the specification of double hurdle model therefore takes the form:

$$A_{ij}^* = \beta_{ik} X_{ik} + \varepsilon_i \text{ (K = } A_1, A_2, A_n) \dots\dots\dots 5$$

where j = 1, 2, 3 and 4 are the banana value addition activity choices while β_{ik} represent the vector of the parameters that shows the impact of changes of the independent variables, X_{ik} is the vector of independent variables and ε_i represents the random error. K shows the utility levels that are obtained from different BVA activity choices.

$$A_i = 1 \text{ if } A_i^* > 1 \dots\dots\dots 6$$

$$A_i = 0 \text{ if } A_i^* < 0 \dots\dots\dots 7$$

A_i^* is the unobserved latent variable showing the probability of choosing a given banana value addition activity.

2.8 Conceptual framework

The conceptual framework for the study is given in Figure 1. Socioeconomic and institutional factors were the independent explanatory variables while adoption and

profitability were the dependent variables. The framework describes the relationship between adoption of banana value addition activities and hypothesized explanatory variables. Further the relationship between adoption of these value addition activities and profitability is shown.

Under socio-economic factors, the study considered farm size in acres, main occupation, area under banana production in acres, gender, age, education level, and household size. On institutional factors there were group membership, access to credit, access to extension, extension contacts, distance to nearest market, number of trainings, experience in banana farming, and type of road. It was hypothesized that these factors could either positively or negatively influence agripreneurs decision and extent to adopt banana value addition. The agripreneurs are expected to get higher gross margins as a result of adoption of value addition. The end result was to increase profitability on banana agri-enterprises which in return improves their livelihoods.

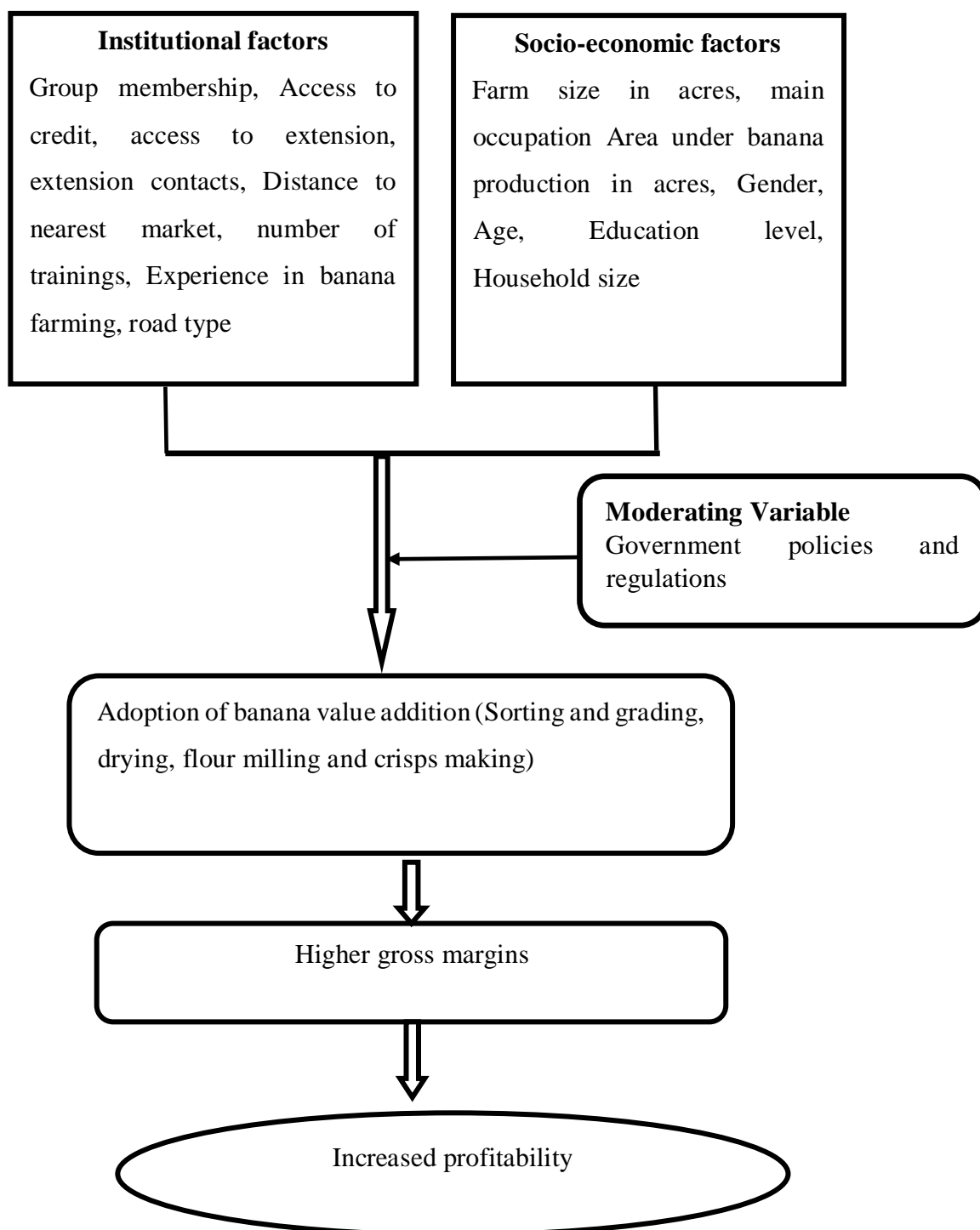


Figure 1. Conceptual framework

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter describes the research methodology which comprised of study area, research design, target population, sampling unit and unit of analysis, sampling procedure, sample size determination, instrumentation, reliability and validity of study, piloting, data collection, descriptive and econometric models for the study.

3.2 Study area

This study was conducted in Kisii County as shown in figure 3.1. The County lies between latitude 0° 30' and 10° 0' South and longitude 34° 38' and 37° 61' East and covers an area of 1,323 square kilometres. It borders Nyamira County to the North East, Narok County to the south and Homabay and Migori counties to the west. Administratively, the county is divided into nine sub-counties, namely; Bobasi, Bonchari, Bomachoge Borabu, Bomachoge Chache, Kitutu Chache North, Kitu Chache South, Nyaribari Chache, Nyaribari Masaba and South Mugirango.

The annual rainfall ranges between 1500 and 2000 millimetres and is received in two seasons. Long rains are experienced from March to June while short rains are received from September to November. Maximum temperatures range from 21°C and 30°C whereas the minimum temperature range from 15°C and 20°C with months between January and July being the dry months. The area is classified into the upper and lower midland zones (UM1, LH1, LM2).

The County has a population of about 1,260,809 persons (Kenya National Bureau Statistics- KNBS, 2019) and agriculture is the main source of livelihood for the residents. This is because of the prevailing agri-ecological conditions that support the growth of both cash crops (sugarcane, tea, coffee) and food crops (maize, beans, vegetables) as well as dairy farming. Banana is ranked second as a source of income after tea in Kisii County (Omondi *et al.*, 2020). Production of bananas are intensified in Bobasi, Bomachoge, Nyaribari and Kitutu Chache North Sub-Counties.

The county was selected because it was the first region among other banana growing areas in Kenya to be oriented and incubated into banana value addition activities. Moreover, more interventions by the national government have been put in place in the county than other counties to promote banana value chain through value addition. Furthermore, Kisii county is

used as bench mark for value addition by other banana growing regions in Kenya (Farmbiz, 2019). Some of the value addition activities are taking place in the County such as cleaning, sorting, grading, drying, milling, and making of crisps (Obaga & Mwaura, 2018).

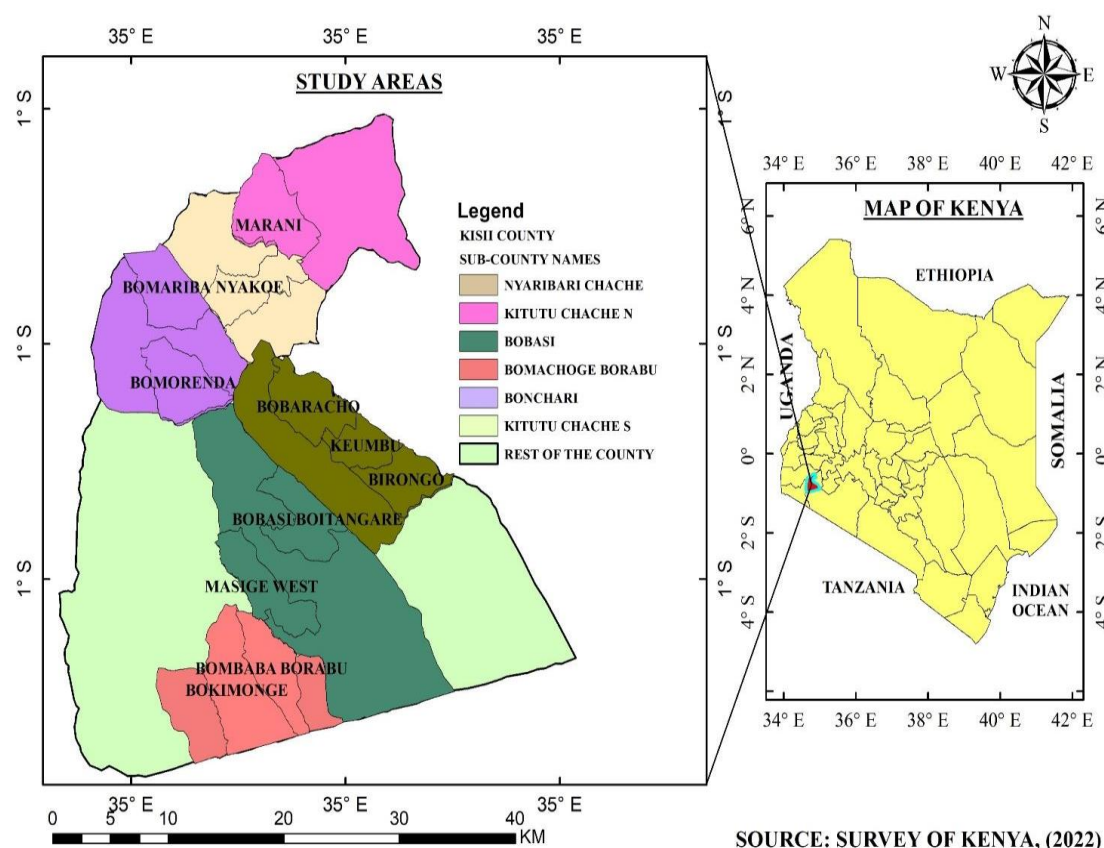


Figure 2. Map of Kisii County showing the study location

3.3 Research design

The study used a descriptive survey design. According to Simuforosa (2015) descriptive survey design allows a researcher to provide answers to the questions of who, what, when, where, and how related to a certain research phenomenon. According to Mugenda and Mugenda (2003), the design allows data to be collected and reported the way the situation was or phenomenon without any form of manipulation. The descriptive survey design was deemed suitable for this study due to the fact that it allowed the researcher to characterise socio-economic and institutional attributes of banana agripreneurs, determine the factors that influence decision and extent of banana value addition and its effect on profitability.

3.4 Sampling approach

3.4.1 Target population of the study

The study's target population was all banana agripreneurs in Kisii County. the production year was 2021-2022.

3.4.2 Unit of analysis and sampling unit

The unit of analysis for this study was the small-scale banana agripreneurs engaged in production and marketing of banana and its products. Built into the epithet "small-scale" is the implication of limited resource for instance, land, capital and labour availability. Therefore, a small-scale agripreneur according to this research is described as a farmer who is involved in production of bananas on less than 3 acres of land. The sampling unit was small-scale banana agripreneurs within the selected Wards in Kisii county.

3.4.3 Sample size determination

According to Al-Sabaihi (2003), Israel (1992), Singh and Masaku (2014) noted that sample size can be determined by using the following approaches, such as a sample size of previous similar study, a census for a smaller population, use of published tables and use of formulars. Moreover, when using Cochran's (1993) formulae for unknown population the sample size can be adjusted according to confidence level, desired precision and degree of variability o attributes of interest within the population (Al-Subaihi, 2003; Israel, 1992). This study used Cochran's formulae to get the sample size due to lack of reputable documentation on the exact population of the targeted respondents in the study area. Israel (1992) and Singh and Masaku (2014) provides a suggestion adjustment for degree of variability or proportion. They recommend a proportion (p) of 80% in situations where the majority in the population have desired attributes and (p) of 20% where majority in the population lack the desired attributes. This study will adopt a (p) of 20% (0.2) on assumptions that only a small proportion of the population had the desired attributes because only a few of agripreneurs in a population had engaged in banana value addition during data collection. Al-Sabaihi (2003), Israel (1992), Singh and Masaku (2014) noted that a proportion of 50% (0.5) is commonly used when there is maximum variability in the population.

$$\frac{Z^2pq}{e^2} \dots\dots\dots 8$$
$$n = \frac{1.96^2 \times 0.2 \times 0.8}{0.05^2} = 245.8 \cong 246 \dots\dots\dots 9$$

Where n is the desired sample size in the target population, ($Z= 1.96$) is the standard normal deviate at the required confidence level of 95%, (p) is the estimated proportion of an attribute in the population (For instance; the proportion of small-scale agripreneurs in Kisii county that was engaged in value addition) ($p = 0.2$), (q) is the proportion of population having no characteristics being measured ($q = (1-p= 0.8)$) and acceptable margin of error is $e= 0.5$.

3.5 Sampling procedure

Multistage sampling technique was employed in the study to arrive at the desired sample size. This technique is widely used because of the following reasons according to Lavrakas (2008); where a sampling frame is not existing and where construction of one maybe too costly to construct. Small-scale banana agripreneurs are widely spread and there is no sampling frame for banana agripreneurs. Another reason is that the research is constrained with time. Therefore, multistage sampling technique was justifiable. Since it enabled the researcher to take advantage of the ranked structure of the target population and design.

The study used three stages multistage sampling technique for selection of sub-counties, wards, treated(adopters) and control group (non-adopters) and banana agripreneurs. On the first stage: five sub-counties namely; Bonchari, Bobasi, Bomachoge Borabu, Kitutu Chache North, and Nyaribari Chache were purposively selected for their ecological potentials to banana production. The five sub-counties are the highest banana producing sub-counties in Kisii County. This was followed by purposive selection of one ward from Kitutu Chache North (Marani), two wards from Bobasi; (Bassi-Bogetaorio, and Bassi-Boitang'are), Bonchari (Bomarima and Bomorenda), and Bomachoge Borabu (Bokimonge and Bombaba) as well as three wards from Nyaribari Chache (Kiogoro, Kisii Central, and Bobaracho), due to orientation of banana value addition activities. He third and last stage involved separation of value adders and non-value adders into two strata whereby census survey was used to select 100 value adders and systematic random sampling to select 146 non-value adders. All the adopters identified were included in the sample. However, a total of 201 respondents were interviewed during the survey as shown in Table 1 below.

Table 1. Proportional distribution of the sample size in the study area

Sub Counties	Wards	Agripreneurs (Adopters)	Agripreneurs (Non-adopters)	Total
Bobasi	Bassi Boitang'are	15	15	30
	Bassi Bogetaorio	12	17	29
Bonchari	Bomarima	10	15	25
	Bomorenda	9	18	27
Bomachoge Borabu	Bokimonge	6	13	19
	Bombaba	7	18	25
Kitutu Chache N	Marani	8	11	19
Nyaribari Chache	Kiogoro	10	9	19
	Bobaracho	13	10	23
	Kisii Central	10	20	30
Total		100	146	246

3.6 Types and sources of data

Primary data were collected from the field and secondary data were obtained from secondary sources such as: books, journals, relevant websites, conference papers, Horticultural Crops Directorate reports, business technology assessment non-governmental organizations implementing banana projects, and department of agriculture which are used in the literature review. The primary data were collected from semi-structured questionnaires with variables including socio-economic and institutional characteristics of banana agripreneurs.

3.7 Pilot study

A pilot study was conducted in Nyamira County which has the same ecological conditions as those of Kisii County to see whether validity and reliability of the instrument is achieved before final data collection. Upon achieving this, trained enumerators visited banana agripreneurs at their various enterprise locations to collect data or homes. Ward Agricultural Officers were contacted to facilitate the field work.

3.7.1 Validity of the study

Validity measures the extent to which the instrument measures what is supposed to measure (Drost, 2011). Instrument validity should be ensured to achieve accurate and consistent results (Mugenda & Mugenda, 2003). The instrument should be both face and content validated. Face validity is the extent to which the respondents view the appearance of the instrument and its items as relevant to the context in which the test is being administered. Whereas content validity checks whether the instrument adequately covers all the content concerning the variables under observation (Heale & Twycross, 2015). Therefore, the researcher warranted the instrument is valid by checking all the items and ensured they are measuring all the variables under observation. The researcher also ensured that the appearance of the questionnaire is appealing to the respondents and did not contain any unnecessary graphics and items that were not part of the study. Moreover, the questionnaire was submitted to the supervisors to help validate the face and content validity.

3.7.2 Reliability of the study

Reliability states the consistency of the instrument in measuring the construct in repeated trials (Drost, 2011). To estimate reliability, a pilot study was carried out in which the questionnaire was administered to a different population from that of the study before it was administered to the actual target population of the study. The questionnaire was piloted in Nyamira county, which has similar agro-ecological conditions with those in Kisii County. A sample of 30 respondents was used, which is more than 10 % of the total sample hence sufficient to carry out the reliability test. (Connelly, 2008). The Cronbach alpha coefficient obtained after testing for reliability was 0.75 which is above the required threshold of 0.7 hence the instrument was found to be reliable.

3.8 Data collection

Primary data (qualitative and quantitative) were collected from cross-sectional survey of banana agripreneurs in the selected wards of Kisii County using semi-structured questionnaires through face-to-face interviews. Information about the socioeconomic and institutional characteristics of respondents, factors influencing utilisation and extent of utilisation of value addition, prices of inputs and output were collected from 201 agripreneurs. Before piloting and even the actual data collection, an ethical clearance was obtained from the

Egerton University Ethical Committee and an introductory letter from Graduate School for securing research permit from the National Commission for Science, Technology and Innovation (NACOSTI). The exercise of data collection was done by trained enumerators and facilitated by the researcher and ward extension officers.

3.9 Analytical framework

The data collected were organized, entered and cleaned (treated) using Statistical Package for Social Sciences (SPSS) version 27, while STATA version 17 was used to analyse the data.

3.9.1 To characterize adopters and non-adopters of value addition among small-scale banana agripreneurs in Kisii County

In this objective, descriptive statistics explained, described, compared, and contrasted between agripreneurs who participated in value addition (adopters) and who did not (non-adopters). For instance, Chi-square (Ch^2), and t-test were used to test for the significance of the differences in characteristics of adopters and non-adopters.

3.9.2 To investigate the factors influencing adoption of banana value addition in Kisii County

There are several models that could be used to analyse factors determining adoption of technologies. In principle, the decisions on whether to adopt value addition and how much quantity to be value added can be made jointly or separately. Therefore, several models could be used. For instance: linear probability model, Tobit model, Heckman two stage model and Double Hurdle (DH) model. Several technology adoption studies have used Tobit model to estimate intensity of adoption of technologies. However, the model suggests that the decision and intensity of adoption of banana value addition are determined by the same factors (Wooldridge, 2013). This may not be the case because the two scenarios are different. This results in a bump of zeros for adopters, leading to a corner solution problem. Therefore, in this study, the first stage of the model was binary (1= decision to adopt; 0= Otherwise), while the second decision with a continuous dependent variable (proportion of bananas value added in kilograms). The zeros in the first step suggests that some agripreneurs made their optimal

decision and not otherwise. In this case, according to Tobin (1958) on a corner solution model, could be appropriate than a Truncated selection model (Ricker-Gilbert *et al.*, 2011).

Heckman Two Stage and DH models are somehow similar in separating discrete and continuous outcomes (Mignouna *et al.*, 2017). Both models assume different or similar sets of variables affecting two decisions (the decision and intensity of adoption) differently. However, Heckman's selection model is more appropriate for controlling selection bias using the Inverse Mills Ratios (IMR) but is opposed to DH because zeros in the Heckman Two Stage model reflect missing responses (Mbitsemunda & Karangwa, 2017). Furthermore, the Heckman Two stage model assumes non-zero responses in the second stage of the hurdle (Mignouna *et al.*, 2017). This shows that banana adopters only participate in the first stage but have no chance to there will be no chance to participate in the second stage (Mal *et al.*, 2012).

Fractional response model could also be used to analyse this objective however it only applies to determining the extent of adoption of banana value addition (proportion of banana value added) only. However, the aim of this objective is to investigate the factors determining the decision and proportion of banana value added. Therefore, DH model became the suitable since it reduces the limiting assumptions of both the Tobit and Heckman Two Stage models. Hence, DH model analysed this objective by integrating both Probit and Truncated normal regression models (Khoza *et al.*, 2019).

DH model does work by modelling the decision and extent to adopt separately, assuming different or similar sets of variables affect the two stages. In DH model, small-scale banana agripreneurs are assumed to pass through two separate hurdles to achieve maximum satisfaction (Eakins, 2016). In this case, the first hurdle in DH model defines the initial discrete decision to adopt ($y > 0$), while the second hurdle defines the extent of utilisation (Khoza *et al.*, 2019). Similarly, the DH model has been widely used in different previous studies, including (Mohamed *et al.*, 2022; Mutinda *et al.*, 2020; Twumasi *et al.*, 2019). In this case, Mohamed *et al.* (2022) specified double hurdle model as:

$$d_i^* = Z_i' \gamma + \varepsilon_i \quad \text{Decision to adopt banana value addition 10}$$

$$y_i^* = X_i' \beta + \mu_i \quad \text{extent of adoption.....11}$$

Whereby d_i^* and y_i^* are the latent variables describing banana value addition utilisation decision (1= adopt banana value addition and 0= otherwise) and the intensity of adoption value addition by banana agripreneurs. Z_i' and X_i' are vectors of observed covariates explained agripreneurs' decision to add value and extent of utilisation, γ and β are vectors of unobserved

parameters, ε_i and μ_i are error terms showed all other factors influence, d and y apart from Z_i' and X_i' . The error terms were assumed to be independent and normally distributed as, $\varepsilon_i \sim N(0, 1)$, and $\mu_i \sim N(0, \sigma^2)$

The combination of the two decisions led to the following estimation models:

$$d_i = Z_i' \gamma + \varepsilon_i \quad \text{if } d_i^* > 0, \text{ and } = 0 \quad \text{Otherwise} \dots\dots\dots 12$$

$$y_i = X_i' \beta + \mu_i \quad \text{if } y_i^* > 0, \text{ and } = 0 \quad \text{Otherwise} \dots\dots\dots 13$$

The two equations above are written as follows

$$\begin{aligned} \text{DEC} = & \gamma_0 + \gamma_1 \text{GEN} + \gamma_2 \text{PRIM_EDUC} + \gamma_3 \text{SEC_EDUC} + \gamma_4 \text{TER_EDUC} + \gamma_5 \text{M_STATUS} + \gamma_6 \text{MAIN_OCCUP} \\ & + \gamma_7 \text{Gen} + \gamma_8 \text{HH_SIZE} + \gamma_9 \text{AGE} + \gamma_{10} \text{FARM_SIZE} + \gamma_{11} \text{OUTPUTPRO} + \gamma_{12} \text{DIST_MKT} + \\ & \gamma_{13} \text{MURRAM_ROAD} + \gamma_{14} \text{TARMC_ROAD} + \gamma_{15} \text{GRP_MEMB} + \gamma_{16} \text{ACC_CREDIT} + \gamma_{17} \text{EXT_CONTACT} + \\ & \gamma_{18} \text{FRAM_EXPER} + \gamma_{19} \text{OFF_FARM_INCOME} \dots\dots\dots 14 \end{aligned}$$

$$\begin{aligned} \text{EXT} = & \beta_0 + \beta_1 \text{GEN} + \beta_2 \text{PRIM_EDUC} + \beta_3 \text{SEC_EDUC} + \beta_4 \text{TER_EDUC} + \beta_5 \text{M_STATUS} + \beta_6 \text{MAIN_OCCUP} \\ & + \beta_7 \text{Gen} + \beta_8 \text{HH_SIZE} + \beta_9 \text{AGE} + \beta_{10} \text{FARM_SIZE} + \beta_{11} \text{OUTPUTPRO} + \beta_{12} \text{DIST_MKT} + \\ & \beta_{13} \text{MURRAM_ROAD} + \beta_{14} \text{TARMC_ROAD} + \beta_{15} \text{GRP_MEMB} + \beta_{16} \text{ACC_CREDIT} + \beta_{17} \text{EXT_CONTACT} + \\ & \beta_{18} \text{FRAM_EXPER} + \beta_{19} \text{OFF_FARM_INCOME} \dots\dots\dots 15 \end{aligned}$$

To take into account for heteroskedasticity and the non-normal error term, the log-likelihood function for DH model, as specified by Carroll *et al.* (2005) was applied as shown.

$$L(\alpha, \beta, \sigma^2) = \Pi_0 \left[1 - \varphi(Z_i' \gamma) \varphi\left(\frac{X_i' \beta}{\sigma}\right) \right] \times \Pi_1 \left[\varphi(Z_i' \gamma) \sigma^{-1} \phi\left(\frac{y_i - X_i' \beta}{\sigma}\right) \right] \dots\dots\dots 16$$

Where φ and ϕ is the standard normal cumulative distribution function (CDF) and density function, respectively. The log-likelihood for the DH model specified above comprises the loglikelihood values estimated in the first hurdle by the probit model and the second hurdle by the truncated normal regression model. Additionally, to determine the effects of explanatory variables on the extent of utilisation of banana value addition, the marginal effects were evaluated. Jensen and Yen (1996) definite the marginal effect as:

$$\left[\frac{y_i}{y_i} > 0 = \phi\left(\frac{X_i' \beta}{\Delta x}\right)^{-1} \int_0^\infty 0 \left[\frac{y_i}{\sigma_i \sqrt{1 + \theta^2 y_i^2}} \phi\left(\frac{\Gamma \phi y_i - X_i' \beta}{\sigma_i}\right) \right] dy_i \dots\dots\dots 17$$

A likelihood ratio test is conducted between the Tobit and Double Hurdle model to determine the correctness of the model. The likelihood ratio test is computed using the following formula:

$$\Gamma = -2[\ln L_t - (\ln L_p + \ln L_{TR})] \sim X_k^2 \dots\dots\dots 18$$

where, L_p , L_t , L_{TR} are likelihood for Probit, Tobit and Truncated regression model respectively and k is the number of independent variables in both the equations. The test hypothesis is written as:

$$H_0 : \lambda = \frac{\beta}{\sigma} \text{ and } H_1 : \lambda \neq \frac{\beta}{\sigma} \dots\dots\dots 19$$

H_0 is rejected on pre-specified significance level, if $\Gamma > X_k^2$. The explanatory variables used in the model and their expected signs are shown in table 2.

Table 2. Description of variables and the expected sign in the double hurdle model

Variable	Description, type of variable and unit of measurement	Decision Expected sign	Extent Expected sign
Dependent			
Banana value addition	Adopt banana value addition 1 =Yes, 0= Otherwise (Binary)		
Extent of adoption	Proportion of banana value added in Kgs		
Independent			
Age	Age of agripreneurs in years	+/-	+/-
Gender	Sex of agripreneurs 1= Male 0 = Female	-	-
Marital status	1 Married 0= Otherwise	-	-
Education Level	1 No formal education 2 Primary level 3 Secondary level 4Tertiary level (Categorical)	+/-	+/-
Household size	Number of family members (continuous)	+/-	+/-
Farm size	Total farm size owned in acres (continuous)	+	+/-
CreditAccess	Access to credit 1 =Yes 0= Otherwise (Binary)	+/-	+/-
ExtContact	Number of extension visits (continuous)	+	+
TrainContct	Number of trainings yearly (continuous)	+	+
Grpmemb	Being a member of group 1= Yes 0= otherwise	+	+
Qty harvested	Total output harvested in kgs (Continuous)	+	+/-
Farm_Exp	Years in banana farming (Continuous)	+	+/-
Distance	Distance to the nearest output market in kilometres (continuous)	+/-	+/-
Occupation	Main occupation of agripreneurs 1 Farming only 0 otherwise (Binary)	+	+/-
Nature of road	Type of roads used 1= Tarmac 2= Murram, 3= Earth (categorical)	+/-	+/-
Off_Farm_Income	Income from non-farm activities in KES	+/-	+/-

3.9.3: To determine the effect of banana value addition on profitability in Kisii County

The most commonly used methods of impact evaluation are the differences in differences approach (DID), endogenous switching regression (ESR) model, propensity score matching (PSM) model and instrumental variables approach (IV) (Julian *et al.*, 2014). The DID is linked with an advantage of removing biases introduced through both observable and unobservable factors. However, it requires pre and post project panel data generated through well designed experimental approaches. The limitation of IV was to find an appropriate instrument variable within the data while ESR allows for the presence of endogeneity. Past studies have employed PSM to evaluate the effect of adopting a technology on incomes and gross margins (Mkandawire, 2018; Piabuo *et al.*, 2015).

PSM is a non-experimental method used to estimate the difference in outcomes (gross margins) between banana agripreneurs (adopters and non-adopters) at farm level. The method reduces the selection bias that may exist in non-experimental data. Selection bias exists when participants have not been randomly allocated to a particular program, and those units that are eligible to participate are systematically different from those who are not. It is essential to draw a counterfactual scenario about the outcome in absence of the intervention for one to infer the impact or effect of an intervention on individual outcome. The challenge lies in the formation of a proper comparison group amid a large group of non-adopters (Caliendo & Kopeinig, 2005).

Rosenbaum and Rubin (1983) suggest matching on the probability of participation, given all observable treatment-independent covariates X. The propensity score of vector X can be defined as:

$$P(X) = \Pr (Z = \frac{1}{X}) \dots\dots\dots 20$$

Where, Z represents the participation indicator which is equal to one if the agripreneurs adds value and zero otherwise. Since propensity score is a balancing score, the probability of participation conditional on X was balanced such that the distribution of observables X was equal for value adders and non-value adders. The differences between both groups were therefore reduced to the only attribute of the assigned treatment and unbiased impact estimates were obtained. The counterfactual group can be known if potential outcomes $Y_1(Y_0)$ of adopters and non-adopters are independent of value addition, conditional on observables X:

$$Y_0, Y_1, \perp \frac{Z}{X \forall X} \dots\dots\dots 21$$

This conditional independence assumption shows that the selection is entirely based on the vector of observables X that determines the propensity score, thus it rules out perfect predictability. In addition, in order to guarantee randomised selection, the common support condition needs to be applied:

$$0 < p(X) < 1 \dots\dots\dots 22$$

It ensures that with same observable characteristics, groups have a positive probability to belong both to the value addition and to control group. The assumptions together ensure that adding value is ignorable and imply that:

$$Y_0, Y_1 \perp \frac{Z}{P(X)} \dots\dots\dots 23$$

If outcomes are independent of value addition given X , then they also do not depend on value addition given $P(X)$. As a result, the multidimensional matching problem is left to a one-dimensional problem. The distribute on of possible outcomes was balanced among adopters and non-adopters.

The probit and logit are standard approaches for estimating models with limited dependent variables (Okelloh *et al.*, 2022). Both yield similar results when estimating the probability of agripreneur participating or not participating in value addition. The study adopted a logit model to estimate propensity scores. The probability of participation, given vector X containing all observable characteristics, can be defined as:

$$P(X) = \Pr(Z = \frac{1}{X}) = F(\beta_1 X_1 + \dots + \beta_n X_n) = F(X\beta) = e^{x\beta} \dots\dots\dots 24$$

Where $F(\cdot)$ produces response probabilities between 0 and 1. After the set-up of the core assumptions and the prediction of the probability of participation, one parameter that measures the differences in outcome between adopters and non-adopters is introduced in the next step. Generally, the difference in potential outcomes can be captured in the treatment effect for an individual, expressed as below:

$$TE_i = Y_{i1} - Y_{i0} \dots\dots\dots 25$$

Where $i = 1 \dots, N$ which represents the total population. One parameter of interest is the average treatment effect on the treated (ATT). Applying the merged assumption of strongly ignorable treatment assignment involving both the independence of the outcome variable from treatment conditional on observable covariates and the common support assumption as introduced above, the real ATT based on PSM, can be presented as:

$$ATT_{PSM} = E_{p(x)} \{ (E(\frac{Y_1}{Z} = 1) P(X) - (E(\frac{Y_0}{Z} = 0) P(X))) \} \dots\dots\dots 26$$

In thought of the non-randomised selection of groups in the project, it might be possible that other unobservable factors had affected the participation decision. Rosenbaum (2002) suggests solving the problem of unknown bias by a bounding approach. Thus, within the logit model to estimate propensity score (equation 16) the probability of participation $F(\cdot)$ needs to be completed by a vector U containing all unobservable variables and their effects on the probability of participation captured by:

$$P(X) = Pr(Z = \frac{1}{X}) = F(X\beta + U\gamma) = e^{X\beta + U\gamma} \dots\dots\dots 27$$

Rearranging the likelihoods ratio of two groups (m and n) who are identical in observable characteristics, the resulting relative likelihoods of participation is given by equation 18.

$$\frac{P(X_m) * (1 - P(X_n))}{1 - P(X_m)} = \frac{e^{\beta n x_n + \gamma_n U_n}}{e^{\beta m x_m + \gamma_n U_n}} = e^{\gamma[U_n - U_m]} \dots\dots\dots 28$$

As long as the U between the two groups is similar or if the unobserved variables have got no effect on the probability of participation, the relative odds ratio becomes one and the selection procedure is random.

After calculation of propensity scores, there is need for an algorithm to match adopters with non-adopters. This is normally based on the closeness of their propensity scores (Wu *et al.*, 2010). Heckman *et al.* (1998) suggested matching algorithms such as nearest neighbour (NN) matching, kernel matching, local linear (LL) matching, radius (caliper) matching and stratified matching. NN matching is the most straightforward matching estimator.

3.9.4 Gross margin analysis

The current study used nearest radius-caliper and kernel matching to estimate the effect of banana value addition on profitability. Profitability as the outcome variable in objective three is obtained by use of gross margin analysis. Gross margin was calculated by subtracting total variable costs from gross revenue.

$$GM_i = TR_i - TVC_i \dots\dots\dots 29$$

Where;

GM = Gross margin

TR = Total (Gross) Revenue

TVC = Total variable costs

(For $i = 1, 2$) either the adopters or non-adopters. Net profits were calculated by subtracting total production costs of banana and value-added costs from gross (total) revenue of selling bananas and value-added products as:

$$\Pi_i = TR_i - TVC_i \dots\dots\dots 30$$

where, π = Net profit

TR = Total revenue

TVC = Total variable cost

Gross (total) revenue was calculated by multiplying stated price of banana or value-added product with the price by quantity of banana yields or value-added product as reported by agripreneurs. Quantity of production included total amount of banana output and was either, marketed, consumed at household level, or gifted out. The value of bananas consumed at household level or gifted out was determined by assuming that it would have been sold at the prevailing price.

The study used current season's (2021/2022) prices and labour costs. Variable costs comprised of inputs and labour costs at production, weeding, harvesting, processing, transportation and marketing. Such inputs included fertilizers, electricity, chemicals, and water. Fixed costs such as depreciation of machines and processing facilities, cost of planting materials such as suckers, land preparation costs were not considered in the study. The variables used in this objective are shown in Table 3.

Table 3. Description of variables and the expected sign in the propensity score matching model

Variable	Description of variable	Measurement	Sign
Dependent			
Profitability	Profits received from banana and its products	KES	
Independent			
Age	Age of agripreneur	Years	+/-
Gender	Gender of agripreneur (Binary)	1 Male 0 = Female	+/-
MaritalStatus	Marital status of agripreneur (Binary)	1 Married 0 Otherwise	+/-
Education Level	Education level of agripreneur (Categorical)	1 No formal education 2 Primary level 3 Secondary level 4Tertiary level	+/-
HouseholdSize	Number of members in a family	Numbers	+/-
Farmsize	Total land size owned	Acres	+/-
Banana Acres	Land size covered by bananas	Acres	+/-
CreditAccess	Access to credit	1 Yes 0 otherwise	+/-
ExtAcc	Extension visists received in year	Number	+/-
TrainContct	Trainings received in a year	Number	+/-
GrpMembShip	Belong in Group membership	1 Yes 0 Otherwise	+/-
Qty_harvesetd	Total output produced	Kilograms	+/-
Farm_Exp	Years in Banana Farming	Years	+/-
Distance	Distance to nearest output market	Kilometres	+/-
Occupation	Main economic activity of agripreneurs (Binary)	1 Farming 0 Otherwise	+/-
Nature of road	Type of roads to used (Categorical)	1 Tarmac 2 Murram 3Earth	+/-
Off_Farm_Income	Income from non-farm activities	KES	+/-

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussions of the three objectives of the study. It starts with the description of the sample which includes the description of the socio-economic and institutional characteristics of the sampled banana agripreneurs (adopters and non-adopters). descriptive statistics such as Chi-square for categorical explanatory variables (categorical) and T-test for continues explanatory variables. The first part also gives a discussion on value added banana products and challenges to value addition among agripreneurs. The second part discusses factors influencing utilisation and extent of utilisation of banana value addition using Double Hurdle (DH) model and the third gives the results on effect of banana value addition on gross margin using Propensity Score Matching (PSM) model.

4.2 Descriptive statistics for the socio-economic and institutional factors of small-scale banana agripreneurs

In sub-section 4.2.1 and 4.2.2, there are continuous and categorical variables indicating the characteristics of adopters and non-adopters.

4.2.1 Socio-economic and institutional characteristics of adopters and non-adopters of banana value addition in Kisii County (continuous variables)

The socio-economic and institutional characteristics of small-scale banana agripreneurs sampled in Kisii County are presented in Table 4. agripreneurs' characteristics are shown by value addition status. The study targeted a sample size of 246 banana agripreneurs in Kisii County (100 adopters and 146 non-n adopters). Out of this target, 201 banana agripreneurs filled the questionnaire fully, which represent 82% response rate. Of total sample, 61 agripreneurs were adopters and 140 were non-adopters respectively. This is because some agripreneurs had stopped adding value during the COVID-19 era, so they were excluded from the sample. The socioeconomic characteristics of banana agripreneurs are presented in Table 4.1 with a discussion on significant variables only.

Adopters were significantly younger than non-adopters at 5% level of significance. The mean age of all agripreneurs was found to be 48.45 years and that of adopters and non-adopters was 45.05 years and 48.05 years respectively. However, the two groups were between

the active and productive age (World bank, 2019). This suggest that younger agriprenuers are risk takers, more dynamic and innovative and they may try to learn to adopt new and improved agricultural technologies compared to older agripreneurs who are reluctant to shift from traditional to new ways of doing agriculture (Shita *et al.*, 2020). This is similar to a study in Uganda by Kyomugisha *et al.* (2018) who reported that potato adopters were younger than non-adopters and the age difference was significant at 5% level. This finding is in contrast to Ng'eno *et al.* (2021) and Grabowski *et al.* (2016) who found that older farmers have experience and willingness to uptake agricultural innovations than younger farmers because they use trial and error method to acquire techniques that best suit them.

Table 4. T- test result of socioeconomic and institutional characteristics of adopters and non-adopters

Variable	Adopters (61) Mean	Non-adopters (140) Mean	(Overall, 201) Mean	<i>t-test</i>	P-value
Age (years)	45.05	49.93	48.45	2.42	0.02**
Household size	5.02	5.44	5.31	1.64	0.10
Farming experience (Years)	20.79	22.54	22.00	1.17	0.25
Total farm acreage	1.55	1.80	1.72	2.14	0.03**
Banana acreage	0.41	0.38	0.39	-1.00	0.43
Kgs produced	0.78	0.54	0.54	-2.43	0.03**
Distance (Kilometres)	7.21	4.56	5.36	-7.08	0.00***
Extension visits (number)	2.64	1.72	2.00	-6.40	0.00***
Off_Farm_Income (KES)	13,816.39	8864.29	10367.16	-1.52	0.13
Annual trainings (Number)	3.23	1.56	2.07	-8.34	0.00***

Note: ** and *** is significant at 5% and 1% level, respectively

Total farm size owned by agripreneurs in acres, on average was 1.720 acres. There was a significant difference at 5% level in land size owned by non-adopters and adopters. 1.55 and 1.80 acres were owned by adopters and non-adopters respectively. Majority of the farmers in Kisii County have small sizes of land because of the growing population (Kiprop *et al.*, 2015).

Non-adopters have relatively large land sizes possibly because they have diversified their land with a number crops that were the main source of income. This contracts with Musyoka *et al.* (2020) who found that mango adopters in Machakos County owned large land sizes which enabled them to increase mango production. This enhanced the decision and extent of mango value addition in the area.

Regarding to quantity of harvested, adopters harvested more than their counterpart at 5% significance level with adopters and non-adopters having 780 and 540 kilograms respectively. Adopters had fewer household members who fed on bananas compared to non-adopters. Moreover, adopters wanted to produce more bananas for consumption and value addition hence more surplus. Thus, used good agronomic practices to increase the production.

Regarding the number of agricultural trainings, adopters had more training than their counterpart at 1% significance level with adopters receiving 3.23 training contacts unlike to non-adopters who received 2.07 training contacts. The significance of training among adopters is plausible due to the nature of the technologies which require some technical skills and knowledge. This finding supports the role of agricultural training in adoption and use of agricultural technologies. Mkandawire *et al.* (2018) also reported that farmers who highly participated in value addition related projects received more agricultural trainings compared to those who did not.

There was a significant difference in the number of contacts with extension service providers between adopters and non-adopter at 1% significance level. All agripreneurs received an average of 2 extension contacts. While adopters received a mean of 2.64 extension contacts while non-adopters an average of 1.72 contacts. Access to extension services facilitates dissemination of new knowledge and information and consequently affect the decision to partake agricultural technologies by small-scale agripreneurs (Khonje *et al.*, 2015; Okello, 2017). Extension service providers avail information to agripreneurs on usage of agricultural technologies. The plausible information is that adoption of new agricultural technologies especially value addition requires more technical information among agripreneurs resulting to more frequent visits and acquiring of advice and knowledge.

Adopters of banana value addition were farther away from output market from their homes compared to non-adopters with a significance difference at 1% level. The mean distance in kilometres for adopters at 7.21 kilometres whereas for non-adopters was 4.56 kilometres. This indicates that shorter distances to the nearest market reduces the likelihood of adding value. The distance to the nearest market is often used as a proxy for ease access to markets

and hence transaction and transport cost. Despite covering longer distances, adding value enable adopters to reduce bulkiness of raw banana especially during transportation hence reducing transportation and labour costs. Far markets are constituted with better prices and agripreneurs gain a competitive advantage. This finding is in conformity with Orinda *et al.* (2017) who stated that potato farmers who were far away from the output market were able to add value. However, the result is in contrary to Kyomugisha *et al.* (2018) who reported that potato farmers who mainly added value were near the output market.

4.2.2 Chi square test results of socio-economic and institutional characteristics of adopters and non-adopters of banana value addition (categorical variables)

The results on institutional and socio-economic characteristics of adopters and non-adopters using categorical variables are discussed in Table 5. The variables such as: access to extension services, access to group membership, type of roads and main occupation of agripreneurs were found to be significant.

In relation to farming as the primary occupation of agripreneurs, 67.16% of the all the respondents practised farming as their main occupation while 32.84% relied on off farm activities as their main source of income. In addition, 88.52 % of adopters relied on farming as their main source of income, meaning these agripreneurs did not take part in off farm activities hence no off-farm income compared to 57.86% of non-adopters conversely. This implied that majority of banana value addition adopters relied on farming as their main source of income and very few had off-farm income as compared to non-adopters. This enabled adopters to spent fully time to continually add value. A higher proportion of non-adopters had other sources of income a part from farming ad however, the difference in occupation between the two categories was statistically significant at 1% significance level.

In relation to group membership, results in Table 5 depicted that, 89.05% of all agripreneurs were members of various agricultural groups. While 96.72% of adopters were members of the social group compared to 84.71% of the adopters. This suggest that adopters were more aware of the significance of being organised in the agripreneur groups in enhancing access to extension services and value addition equipment. The difference was statistically significant at 5% significant level. Group membership enable interactions and information sharing thus increasing their knowledge and skills to upscale banana value addition agri-enterprises (Ong'ayo *et al.*, 2017). This finding is similar to Orinda *et al.* (2017) who found that group membership helps agripreneurs to access the trainings and advice from various sources on agricultural technologies with ease.

The results showed that majority of the banana agripreneurs (88.09%) accessed extension visits. While, 96.72% of adopters accessed extension visits within the last 12 months in contrast to 84.29% of non-adopters. Access to extension services facilitates in information and knowledge sharing to small-scale agripreneurs. It enables the banana agripreneurs to manage their productivity properly and as a result, promote the proper exploitation of banana value-added products (Bekuma, 2018; Tarekegn & Ayele, 2020). The difference in extension access between the two groups was statistically significant at 5% level of significance. This finding is consistent with the findings of Musyoka *et al.* (2020) who found that extension contact was positively and statistically significant at 5%. Although many agripreneurs accessed extension services, still there is extension service gap on banana value addition in the study area since many are using indigenous knowledge in adding value especially the crisps (Beyene *et al.*, 2017).

The variable “nature of roads” was broken down into earth, murram and tarmac. On average 46.27% of agripreneurs accessed earth roads, followed by murram roads (27.36%) and lastly tarmac roads (26.37%). Among the adopters 9.84% accessed earth compared to 62.14% of non-adopters. On the other hand, 11.48% of adopters used the tarmac roads in contrast to 32.86% of non-adopters. Conversely, 78.69% of adopters accessed murram roads compared to 5% of non-adopters. The mean difference in the type of road accessed between adopters and non-adopters was positive and statistically significant at 1% significant level. Moreover, majority of adopters accessed murram roads while non-adopters accessed earth roads. This simply imply that non-adopters sold at farm gate to avoid more transaction cost since earth roads are impassable Access to good road networks make it easier to transport agricultural products to the market. This finding is similar to Maku *et al.* (2020) who reported that rural road improvement increases production and adoption of agricultural technologies as well as promotes agri-enterprises in agricultural commodity value chains.

Table 5. Chi square test results of socio-economic and institutional characteristics of both adopters and non-adopters of banana value addition

Variable	Overall (201)	Adopters (61) (%)	Non- adopters (140) (%)	Chi²	P- value
Education Level					
1= non-formal education	10.95	11.48	10.71	1.27	0.74
2= Primary level	28.36	22.95	30.71		
3 =Secondary level	40.80	44.26	39.29		
4=Tertiary level	19.90	21.31	19.29		
Gender					
1 =Male	46.26	37.70	50.00	2.58	0.11
0= Female	53.73	63.30	50.00		
Marital status					
1 =Married	80.10	78.69	80.71	0.11	0.74
0= Otherwise	19.90	21.31	19.29	19.88	
Primary Occupation					
1= Farming only	67.16	88.52	57.86	18.12	0.00***
0 = Otherwise	32.84	11.48	42.14		
Type of the road					
1=Earth	46.27	9.84	62.86	116.80	0.00***
2 =Tarmac	26.37	11.48	32.86		
3 =Murram	27.36	78.69	5.00		
Group membership					
1=Yes	89.05	96.72	84.71	5.28	0.01**
0 =Otherwise	10.95				
Access to credit					
1= Yes	41.29	37.70	42.86	0.47	0.50

Note: *** and ** 1% and 5% significant level

4.2.3 Descriptive statistics of banana value addition activities adopted in Kisii County

Table 6 shows the summary of banana value addition practices utilized in the area. Majority of small-scale banana agripreneurs are involved in flour milling with crisps making being the least adopted practice. Crisps making is expensive in terms of cooking oil, electricity, and packaging. Moreover, sorting and grading is simple but leads to deteriorating the of quality of bananas when not sold in time.

Table 6. Summary of banana value addition activities adopted in Kisii County

Banana value addition activities	%
Flour milling	36
Slicing and sun/solar drying	31
sorting and grading of bananas	26
Making of banana crisps	7
Total	100

No multiple responses

4.3 Factors influencing adoption and extent of adoption of banana value addition

4.3.1 Preliminary diagnostics on the variables used in the DH model

Preliminary tests in the socioeconomic and institutional variables were conducted for multicollinearity and heteroskedasticity before running a DH model. Variance Inflation Factor (VIF) was conducted for continuous explanatory variables. The results revealed that there was no serious linear association among all continuous explanatory variables used since VIF values were less than 10 as shown in Table 7.

Contingency coefficient test was also conducted for explanatory categorical variables and results presented in Appendix B. The result concluded that there was no multicollinearity problem among explanatory variables because contingent coefficients were less than 0.75.

Heteroskedasticity test was detected using White test. The results depicted that there was presence of heteroskedasticity since the Ch^2 value of 194.91 was significantly large. However, robust standard errors were used. Results are shown in Table 8.

Table 7. Variance inflation factor results for continuous explanatory variables

Variable	VIF	1/VIF
Age of agripreneurs in years	4.63	0.216
Years in banana farming	456	0.219
Number of annual trainings received	1.29	0.773
Annual extension contacts received	1.22	0.823
Distance to the nearest market in kilometres	1.12	0.894
Far size in acres	1.09	0.915
Off farm income in KES	1.07	0.938
Household size (Number)	1.05	0.956
Mean VIF	2.00	

Table 8. Heteroskedasticity test using the White test

Source	Ch^2	df	p-value
Heteroskedasticity	194.910	195	0.488
Skewness	45.990	19	0.001
Kurtosis	8.060	1	0.005
Total	248.970	215	0.056

4.3.2 Factors influencing decision to adopt banana value addition among small-scale agri-enterprises in Kisii County

DH model was used to simultaneously examine factors determining decision and intensity of adoption of banana value addition. The model was estimated using Stata command *Craggit*. The log pseudolikelihood for the fitted model was -151.452 which was strongly significant at 1% significant level with a Wald Chi-square value of 65.93. the factors to determine the adoption decision of banana value addition is shown in Table 9.

The primary occupation had a positive and significant influence on probability to undertake banana value addition at 1% significant level. Farming being the main source of livelihoods, the likelihood to add value increased by 200%, keeping other factors constant. This

implies that agripreneurs whose main economic activity is farming (crops and livestock production) have higher likelihood to take part in value addition compared to those who participate in non-farm activities. Those who depend on farming as their main source of livelihood take their full time in the farm hence produce more surplus for value addition. This finding is similar to Barbra and Sam (2020) who found that smallholder farmers whose main occupation was farming were most likely to adopt banana tissue culture in Uganda.

In relation to fresh bananas, total quantity of bananas produced influenced the probability to add value positively and significantly at 5% significant level. This indicates that the more agripreneurs produce, the more they become motivated to add value due to more surplus after domestic consumption. It increases the likelihood to participate in value addition by 22.08%. This result is similar to that of Orinda *et al.* (2017) and Falola *et al.* (2016) who found that farmers who had surplus sweet potato and cassava tuber harvests were most likely to add value than those who did not.

The coefficient of distance in kilometres from agripreneur's home to the nearest market was positive and significant at 1% significant level. This plausibly means that agripreneurs who covered longer distance to output market from their homes had a higher likelihood to add value than those who stay near the output market. As the distance from agripreneur's home rises by one kilometre, the probability to participate in value addition increased by 20.65% *ceteris paribus*. The study corroborates with that of Tadele *et al.* (2014) and Beyene *et al.* (2017) who noted that dairy farmers who were nearer the market place, had lower chances of adding value to milk in Ethiopia. The finding of the study is also in line with Konja *et al.* (2023). Further, Mujeyi *et al.* (2022) noted that output markets that are far from home in most cases sometimes have higher prices. However, the study's finding disagreed with that of Maku *et al.* (2022) who reported that as the distance to the market increased by one kilometre, the probability of youths to participate in maize value addition in Uganda declined by 13.01%.

Type of the road, for instance murram roads influenced the decision to add value positively and significantly at 1% level of significance. Moreover, access to murram road increased the probability to add value by 307.23%. Murram roads are type of rough roads with gravel. This type of road was better off in reference to earth roads which are not passable during rain seasons hence having a positive coefficient. Road networks act as proxy to access to markets. Road types were categorised as earth, murram and tarmac roads. They are a key factor to value addition decision because they enable goods to reach the market in good condition and on time. Good road networks reduce transaction and transportation costs hence agripreneurs

maximizing the profits. Utilizing a transport network is a major transactional costs and accounts for up to 50% of production costs in sub-Saharan Africa (Fintrac, 2015). This is similar to Maku *et al.* (2022) who documented that improving rural road networks enhances production and adoption of agricultural technologies.

Table 9. Factors influencing decision to adopt banana value addition among small-scale agripreneurs

Variables	Marginal Effect(dy/dx)	Robust Std. Err.	P> z
Gender of the agripreneur (1= Male, 0= Female)	0.051	0.406	0.900
Attained primary education (Yes/No)	-0.807	0.687	0.240
Attained secondary education (Yes/No)	0.347	0.651	0.594
Attained tertiary education (Yes/No)	0.975	0.829	0.240
Marital status (1= married, 0=Otherwise)	-0.254	0.528	0.631
Main occupation (1=farming, 0= No)	2.006***	0.535	0.000
House hold size (Number)	-0.033	0.131	0.801
Age (Years)	-0.046	0.037	0.209
Farmsize (Acres)	-0.419	0.288	0.146
Output harvested (kilograms)	0.221**	0.101	0.029
Training contacts (Number)	0.537***	0.137	0.000
Off_Farm_Income (KES)	-0.016	0.051	0.747
Distance to nearest output market (Km)	0.207***	0.078	0.008
Used Murram road (Yes/No)	3.072***	0.488	0.000
Used Tarmac Road (Yes/No)	-0.170	0.779	0.727
Group membership (Yes/No)	1.238*	0.732	0.091
Access to credit (Yes/No)	-0.494	0.361	0.170
Extension contacts (Number)	0.793***	0.294	0.007
Farming experience (Years)	0.067	0.046	0.148
Constant	-6.868***	2.143	0.001
Number of observations = 201	Wald Chi ² = 81.460		
Prob> Chi ² =0.000	Log Likelihood = 269.92009		

Note: ***, **, * denote significant at 1%, 5% and 10 % levels, respectively,

Number of agricultural trainings received by agripreneurs influenced the probability to take part in banana value addition positively and significantly at 1% significant level. This means that an increase in one training, the probability to undertake banana value addition increases by 53.66%, keeping other explanatory variables constant. Trainings enable agripreneurs to get access to value addition information, knowledge and skills and also guarantee them on the choice of the most profitable form of value addition activities. Melembe *et al.* (2021) justified that agri-enterprises with access to value addition training have a higher probability to embrace both post-slaughter and milling types of value addition among women processors in South Africa. This finding is similar to Kirimi *et al.* (2021) who documented that smallholder farmers in Meru and Tharaka-Nithi counties, Kenya, who underwent numerous trainings on several methods of banana value addition, were 25 times likely to use selected banana value addition technologies than those farmers who did not

Group membership was positively significant at 10% significant level. Being in a group membership, rises the propensity to add value to banana fruit by 123.84% *ceteris paribus*. This possibly means that being in a group or cooperative enable agripreneurs to easily receive trainings, credit facilities, participate in collective marketing and buy value addition equipment as they pool their resources together. This is consistent with the findings of Amadi (2020), and Tijani *et al.* (2022) that farmers who participate in cooperative society activities tend to adopt cassava value addition, tomato value addition technologies and improved agricultural technologies respectively. However, the finding conflicts that of Isaac *et al.* (2020) who found that cooperative membership had a negative influence on adopting value addition of fish processing in Nigeria. The study further disagrees with that of Kehinde and Aboaba (2016) and Wondim *et al.* (2023), who suggested that group membership was negatively significant at 1% and decreased the participation decision to add value to milk by 64%. Access to credit facilities had a negatively significant influence at 10% level of probability as shown in Table 9. This possibly mean that the more the agripreneurs easily obtain the credit, the propensity of adding value to banana fruit decreased by 60.89% in the study area, *ceteris paribus*. This possibly means that banana agripreneurs who received credit, did not use it for value addition, instead they used that credit to meet other needs such as paying school fees, buying seeds, fertiliser, paying medical bills, buying food among others. This was not expected because access to credit makes it possible for agripreneurs to buy value addition inputs and this helps them in to increase the quantity of banana that they could value add (Adenoyu *et al.*, 2016).

In regard to extension contacts, results depicted that the variable had a positive and significant coefficient of influence on the decision to add value to banana fruit at 1% significant level. Upon receiving one more extension visit, the probability to add value to banana fruit increased by 79.30%. Access to extension services avail agricultural and technology information to agripreneurs, such as how to transform their raw banana fruit into value-added products (Falola *et al.*, 2016). Correspondingly, extension services provide knowledge, skills and information that enables farmers and agripreneurs to be aware, conversant and utilise the agricultural technology or innovation (Mujeyi *et al.*, 2022). This finding is in line with Agoh (2021) and Nmerengwa *et al.* (2022) who deduced that extension contacts positively and significantly influenced adoption of sweet potato value addition in Nigeria. However, this result is in contrary to that of Maku *et al.* (2022) who revealed that extension contact showed a negatively significant association on using maize value addition by youths in Uganda.

4.3.3 Factors influencing extent of adoption of banana value addition in Kisii County

This is the second step of DH model that use truncated regression to determine the extent of utilisation of banana value addition. In this step, amount of banana value added converted into kilograms measured the extent of banana value addition. Results of the Maximum Likelihood estimation revealed that four variables such as; marital status, output harvested, extension contacts, farming experience, and access to credit had a significant effect on extent of adoption of banana value addition as shown in Table 10.

Extension contacts by agripreneurs from extension service providers positively and significantly influenced the kilograms of banana fruit value added at 10% significant level. The implication of this is that an increase in one extension contact would increase the proportion value added by volume of value-added banana by 0.83% *ceteris paribus*. Extension contacts enable promotion of value addition skills through transformation of information, trainings, workshops and seminars to agripreneurs by extension agents hence improving their skills, knowledge and experience. This result is in agreement with that of Musyoka *et al.* (2020) who documented that an increase in one extension contact increased the proportion of mangoes that were value-added in Machakos County, Kenya.

Table 10. Factors influencing extent of adoption of banana value addition among small-scale agripreneurs

Variables	Coefficient	Robust std. Err	P> z
Gender (1= Male, 0= Female)	-0.011	0.009	0.207
Primary level (Yes/No)	0.016	0.011	0.172
Secondary level (Yes/No)	0.021	0.015	0.149
Tertiary level (Yes/No)	0.215	0.019	0.254
Marital status (1=Married 0= Otherwise)	-0.016**	0.007	0.023
Main occupation (Farming/No)	0.009	0.009	0.290
House hold size (Number)	-0.000	0.003	0.976
Age (Years)	0.001	0.008	0.166
Farm Size (Acres)	-0.002	0.005	0.645
Output harvested (Kilograms)	0.007***	0.003	0.010
Trainings (Number)	0.002	0.004	0.454
Off_Farm_Income (KES)	-0.007	0.001	0.405
Distance to nearest output market (Km)	0.001	0.001	0.543
Used murram Road (Yes/No)	0.008	0.011	0.460
Used Tarmac Road (Yes/No)	0.033***	0.012	0.010
Grp membership (Yes/NO)	-0.315	0.028	0.270
Access to credit (Yes/No)	-0.019*	0.011	0.082
Extension contacts (Number)	0.008***	0.003	0.011
Farming Experience (Years)	-0.001*	0.000	0.076
Constant	-0.149*	0.080	0.405
Sigma constant	0.010***	0.002	0.000
Observations = 201	Prob> Chi ² = 0.000		
Wald Chi ² = 81.460	Log Likelihood = 269.920		

Note: ***, ** and * denote significant at 1%, 5% and 10% levels, Base category for education level is non-formal education, type of the road is Earth Road.

Marital status negatively influenced the extent of value addition negatively and significantly at 5% significant level. This implies that the variable decreased the proportion of banana value-added by 1.64% the proportion to be value a. The married couples have higher chances to increase the quantity of bananas value added compared to those not married. Married people have a higher number of family members and other dependants hence diversifying their income sources through value addition to provide the needs for the family. This is similar to Ali *et al.* (2018).

Regarding the nature or type of roads accessed by agripreneurs to output market was broken into earth, murram and tarmac. Tarmac roads had a positive and a significant influence on the extent of banana value addition at 1% significance level. The more agripreneurs accessed tarmac roads, the extent of banana value addition increased by 3.30%, keeping other factors constant. Roads are used as a proxy to access the markets. Well-constructed roads enable agricultural products to reach in the market faster and timely. Not only this but also, good roads reduce transaction costs incurred during transportation of products to the market. Moreover, buyers could be attracted by the good infrastructure, which facilitates rapid transportation of the banana fruit and its value-added products to the market thereby reducing post-harvest losses. Utilising a transport network is a major transactional costs and accounts for up to 50% of production costs in sub-Saharan Africa (Fintrac, 2015). This finding is in line with those of Maku *et al.* (2022) who documented that improving rural road networks enhances production and adoption of agricultural technologies.

Total quantity produced per acre determines the volume to value add. The quantity of banana harvested in kilograms had a positive and significant influence at 1% level of significance. Addition of one kilograms of banana fruit harvested, the proportion of banana fruit value- added increased by 0.72%. This plausibly means agripreneurs producing more quantities of bananas have enough for domestic use and the surplus for surplus for value addition. Therefore, most likely to participate and continue to add value compared to those who produce less and consume everything or remain with less surplus. The result conforms with some studies; Falola *et al.* (2016) and Orinda *et al.* (2017). However, the result contradicts with that of Oluwatayo *et al.* (2022) who documented the more quantities of cassava produced, results to a lower probability of the cassava farmers to engage more in cassava value addition in Oyo State, in Nigeria because more produce can perish before all is used in value addition since cassava tuber is a perishable commodity

Access to credit by agripreneurs had no significant effect on decision to participate in banana value addition however, it showed a negative significant effect on intensity of value addition by 10%. Agripreneurs with access to credit have higher chances to invest on non-banana value addition activities. According to the coefficient (0.01908), the proportion of bananas value added reduced by 1.91%. This result is similar to that of Bosompen *et al.* (2024) who found that access to credit among cassava farmers in Ghana had a negative significant effect on decision and extent of participation on cassava value addition.

Farming experience on banana farming had no significant effect on decision to participate in banana value addition however, it had a negative significant effect on intensity to participate at 10%. It led to the proportion to be value added decreased by 0.11%. The plausible justification is that an agripreneurs may have practiced many years in banana farming but reluctant to get involved in banana value addition. Moreover, may be involved in banana farming as a commercial business with little or no adoption of value addition practices. Furthermore, agripreneurs may be having limiting factors such as low levels of education and lack of trainings related to uptake of value addition, despite having many years in farming (Pappu *et al.*, 2015). Many agripreneurs come from rural areas practice subsistence farming associated with low production which may not motivate them to get engaged in value addition activities (Pereira & Maraschin, 2015). Agripreneurs with many years of experience become rigid to shift from old ways of doing agriculture to adoption of innovations and value addition technologies (Tarrés *et al.*, 2017).

4.4 The effect of banana value addition on profitability in Kisii County

To determine the effect of banana value addition on gross margin, first the gross margin analysis was conducted to estimate the total revenues and total variable costs of banana adopters and non-adopters. All the variable cost per acre (weeding cost, harvesting cost, cost of buying manure, cost of applying manure, storage cost, transport cost, marketing cost and value addition cost) and total revenue of banana fruit and value-added products per acre between the two groups were estimated as shown in Appendix 6. T-test was then used to test the significance difference of the estimated costs and revenues.

4.4.1 Multicollinearity test for continuous and categorical variables used in propensity score matching model

Before the PSM was conducted, preliminary tests were undertaken to check for heteroskedasticity and multicollinearity in the data. Multicollinearity was determined by using

VIF for continuous variables as shown in Table 11 and pairwise correlation for categorical variables as shown in Table 12. The results in Table 4.8 show that mean value of VIF is 2.21 which is below the threshold value of 10. Same case to pairwise correlation, for categorical variables, the values range from 0.0151 to 0.4115 which is below the threshold of 0.75. This shows that there was no presence of multicollinearity to the selected variables (Greene, 2018; Okelloh *et al.*, 2022).

Table 11. Variance inflation factor results for continuous explanatory variables used in PSM model

Variable	VIF	1/VIF
Age of agripreneur head	4.63	0.216
Years of experience in banana farming	4.54	0.220
Farm size in acres	1.49	0.672
Kilograms of banana harvested	1.46	0.684
Distance to the nearest market	1.20	0.833
Number of trainings received	1.15	0.866
House hold size	1.04	0.966
Mean VIF	2.21	

Table 12. Pairwise correlation results for categorical explanatory variables used in PSM model

	Gender	Educ_Lev	Ext_Acc	Grp_Mem	Marital
Gender	1.0000				
Educ_Lev	0.1669	1.0000			
Ext_Acc	-0.0583	0.1469	1.00000		
Grp_Mem	-0.0582	0.0757	0.4115	1.0000	
Marital status	-0.0623	-0.0978	-0.0298	-0.0151	1.0000

4.4.2 Heteroskedasticity test or explanatory variables using White test

Heteroskedasticity test was detected using White test. The results depicted that there was presence of heteroskedasticity since the Ch^2 value of 120.88 was significantly large. However, robust standard errors were used. Results are shown in Table 13.

Table 13. White test for the detection of heteroskedasticity

Source	Chi ²	df	p-value
Heteroskedasticity	120.88	109	0.206
Skewness	37.73	14	0.001
Kurtosis	0.65	1	0.420
Total	159.26	124	0.627

4.4.3 Estimation of propensity scores of bananas agripreneurs using probit model

These results are presented in Appendix IV. Probit regression models was used to estimate the propensity scores of banana adopters and non-adopters. The dependent variable took the value of one if the agripreneur utilizes value addition and 0 otherwise. Then balancing properties of the propensity scores were checked, these were done by using different specifications of the probit models. The results reported in Table are the specifications that gave more robust results which satisfied the balancing tests. According to the findings, the estimated model appears to perform well for the intended matching exercises. The models have McFadden pseudo-R-square value of 0.417 and log likelihood value of -71.880.

4.4.4 Region of the common support

Figure 3 and 4 describes the resulting probability of adopters and non-adopters. Region of common support ensures that treatment observations have comparison observations nearby in the propensity score distribution (Heckman *et al.*, 1998). Results in Table 14 and figures 3 and 4 indicate that there were cases that were out of the region of support. When the proportion of lost individuals is small, this poses less problems (Bryson *et al.*, 2002). However, in this study 53 and 7 agripreneurs in the untreated group (non-adopters) and treated group (adopters) were excluded because they were off support. Therefore, this means that only individuals between the treatment and control group that were on support region were included in the comparison and they included 87 from the untreated group and 54 from the treated group.

Table 14. Region of the common support

Assignment	Off support	On Support	On support
Untreated	53	87	140
Treated	7	54	61
	60	141	201

4.4.5 Testing the matching quality

The main objective of estimating propensity scores is to balance the distributions of relevant variables in both groups (Ganewo *et al.*, 2022). Consequently, the selected matching algorithms have created a covariate balance between adopters and non-adopters. As depicted in Table 16, the standard bias difference between identified explanatory variables before matching was in the range of 9–45% in absolute value. But after matching by using the best algorithm, the remaining standard bias differences between explanatory variables lay between 5 and 74.80% in absolute value. The Chi-square test for joint significance radius caliper 0.1 had the low pseudo-R² value (0.03) and considerable mean bias of 9.7. The insignificant likelihood ratio test revealed that both groups have the same distribution in all covariates after matching.

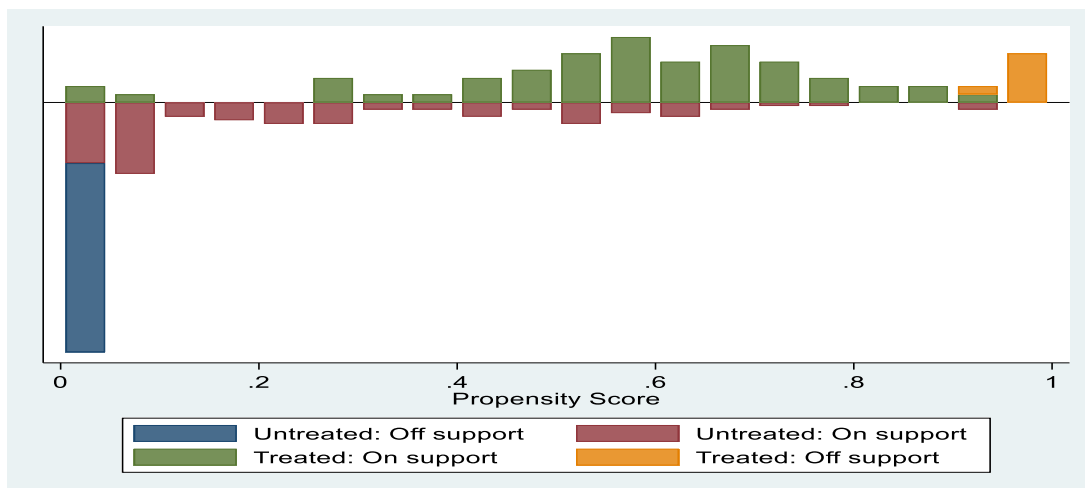


Figure 3. Propensity scores on region of common support using radius matching (0.1)

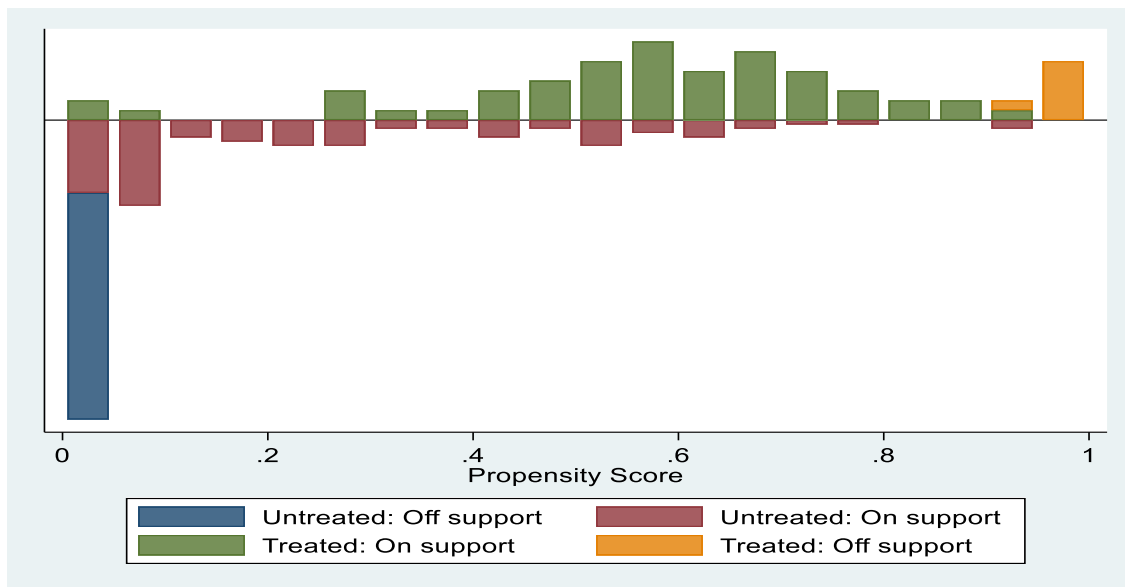


Figure 4. Region of common support using kernel bandwidth matching (0.25)

4.4.6 Balancing tests for propensity score matching quality indicators

A balancing property test of the generated propensity scores was conducted (Table 16), followed by testing the matching quality using different matching algorithms as indicated in a brief guide to decisions at each step of the propensity score matching (Harris & Horst, 2016; Rosenbaum & Rubin, 1983). The results indicated the Pseudo R^2 , the mean and median bias were high before matching but reduced significantly after matching.

The results also reported a number of significant differences in covariates between adopters and non-adopters before matching, which became insignificant after matching for all matching methods, thus confirming success of the matching procedure. The results using Radius caliper 0.1 showed that pseudo R^2 reduced from 0.417 to 0.030. The likelihood ratio reduced from 102.98 to 4.56 and the mean bias also reduced from 29.4 to 8.2.

Results on Table 15 revealed that estimated pseudo R^2 reduced from 0.417 to 0.030 under Kernel 0.25. The mean bias reduction after matching ranged was over 74% across all the matching algorithms. The mean bias after matching ranged from 9.9 to 9.7. This result fulfils the condition that the Pseudo R^2 should be lower whereas the p-value of the likelihood ratio tested should be insignificant, to confirm a successful match (Kwizerimana *et al.*, 2023).

Table 15. Balancing tests for propensity score matching quality indicators

Sample	Radius-Caliper (0.1)	Kernel (0.25)
Pseudo R ² Unmatched	0.417	0.417
Pseudo R ² Matched	0.030	0.030
LR Chi ² Unmatched	102.98	102.98
LR Chi ² Matched	4.56	4.49
P>Chi ² Unmatched	0.000	0.000
Mean Bis Unmatched	38.5	38.5
Mean Bias Matched	9.7	9.9
Median Bias Unmatched	29.4	29.4
Median Bias Matched	8.2	8.9
% Mean Bias Reduction	74.81	74.29
% Median Reduction	72.11	69.73

4.4.7 Testing for matching quality

The study used radius caliper 0.1 and Kernel matching bandwidth of 0.25 to estimate the Average treatment effect on treated (ATT). The control group for this analysis were the small-scale banana agripreneurs who did not participate in value addition. The results obtained using the radius 0.1 was considered since it had small pseudo R² and considerable reduced mean bias of 9.7. This was used to come up with the matching quality as shown Table 15.

4.4.8 ATT of banana value addition on profitability

Table 17 shows the ATT estimation on effect of the utilization of banana value addition on gross margin per acre based on propensity scores. Results revealed that utilising banana value addition had a positive effect on gross margins among the small-scale banana agripreneurs in Kisii County.

Banana value addition increased gross margins by; KES 45,510.72 per acre for Kernel Based Matching and KES 45,451.10 per acre for Radius-Caliper matching and the effects for both groups were significant at 1%. The results based on the two matching algorithms revealed that the ATT estimates were robust. The overall average gain of the total gross margins ranged from KES 45, 451.10 to KES 45, 510.72 which were significant at 95% confidence level. In

terms of percentage increase, this translated to 158.85%. The implication was that assuming there was no selection bias due to unobservable characteristics; gross margins per acre for agripreneurs who adopted banana value addition was significantly higher than of non-adopters

The rise in profitability for banana agripreneurs who added value can be due to extra efforts applied on agricultural produce. Increase in profits is associated with better prices offered by banana value-added products This is supported by several studies on impact of agricultural value addition on farm incomes (Korir *et al.*, 2020; Mkandawire *et al.*, 2018; Oluoch *et al.*, 2016).

Table 16. Balancing of individual covariates

Variable	U	Means		Bias	%	t-test	
		M	Treated			Control	reduction
							Bias
Kilograms of banana harvested	U	10196	6846.20	40.6		2.58	0.01
	M	10141	10637	-6.8	85.2	-0.24	0.81
Gender of agripreneurs	U	0.38	0.50	-24.8		-1.61	0.11
	M	0.39	0.48	-18.5	25.6	-0.98	0.33
Age of agripreneurs in years	U	45.05	49.93	-38.3		-2.42	0.02
	M	45.05	45.91	-2.5	93.6	-0.14	0.89
Primary level of education	U	0.23	0.30	17.5		-1.12	0.26
	M	0.21	0.16	10.00	42.6	0.60	0.55
Secondary level of education	U	0.44	0.39	10.00		0.66	0.51
	M	0.47	0.56	-16.7	-66.2	-0.88	0.38
Tertiary level of education	U	0.21	0.19	5.0		0.33	0.74
	M	0.21	0.22	-3.5	-30.4	-0.18	0.86
Household size of agripreneurs	U	5.02	5.44	-25.2		-1.64	0.10
	M	5.02	5.14	-8.7	30.4	-0.47	0.64
Primary occupation	U	0.43	0.50	-14.7		-0.96	0.34
	M	0.40	0.35	10.3	65.4	0.56	0.57
Banana farming experience	U	20.79	22.54	-17.8		-1.17	0.25
	M	21.21	11.15	0.6	96.7	0.03	0.98
Total land size owned in Acres	U	1.55	1.80	-33.6		--2.14	0.03

	M	1.59	1.71	-15.9	52.7	-0.77	0.44
Number of extension visits	U	0.97	0.84	43.5		2.53	0.01
	M	0.97	0.99	-7.8	82.0	-0.78	0.44
Access to group membership	U	0.97	0.86	39.5		2.32	0.02
	M	0.97	0.96	0.8	98.0	0.66	0.95
Marital status of agripreneurs	U	0.79	0.81	-5.00		-0.33	0.74
	M	0.77	0.79	-3.0	28.7	-0.18	0.85
Distance to the market in Km	U	7.21	4.56	105.1		7.08	0.00
	M	6.79	6.19	23.7	77.4	1.23	0.22
Number of trainings received	U	3.2	1.56	133.0		8.34	0.00
	M	3.14	3.18	-3.3	97.5	-0.19	0.85

Note: U is Unmatched and M is Matched, Km is kilometres

Table 17. Average treatment effect on the treated for small-scale banana agripreneurs' profit (KES) per acre

Algorithm	Sample	Treated	Control	Difference	SE	T-stat
Radius-Caliper	Unmatched	70,158.58	17,455.93	52,702.65	4,857.29	10.85
(0.1) Matching	ATT	74,160.77	28,709.67	45,451.10	8,114.53	5.60***
Algorithm						
Kernel band	Unmatched	70,158.58	17,455.93	52,702.65	4,857.29	10.85
Width (0.25)	ATT	74,160.77	28,650.05	45,510.72	7,961.83	5.72***
Matching						
Algorithm						

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the study, conclusions derived from the findings of the study, policy recommendations and areas for further research.

5.2 Summary

Bananas are among the important fruit crops cultivated in the tropical and subtropical regions. They are known for their good taste and high nutrition. Bananas have health and economic benefits since they are source of starch, vitamins and mineral, income to small-scale agripreneurs and employment along its value chain. Moreover, bananas are processed into other products through value addition to increase its usability and economic returns. Despite the importance of bananas, its production and marketing has been associated with many challenges including post-harvest losses, inadequate market access and fluctuating market prices. Besides, banana agripreneurs have been experiencing the challenge of fluctuating market prices, inadequate storage facilities and exploitation of middlemen who buy bananas at throwaway prices. Adoption of banana value addition is an important pathway to help banana agripreneurs minimize postharvest losses, enhance access to markets and stabilize the market prices. The adoption of banana value addition including sorting and grading, flour milling, drying, crisps making, among agripreneurs in Kisii County, Kenya has remained significantly low. Previous studies have looked at value addition of bananas to various products with little focus on factors influencing adoption of banana value addition and evaluation of banana value addition on profitability.

The specific objectives of the study were (i) To characterize small-scale adopters and non-adopters of value addition among banana agripreneurs in Kisii County, Kenya (ii) To determine the factors influencing adoption of banana value addition in Kisii County, Kenya (iii) To evaluate the effect of banana value addition on profitability among small-scale agri-enterprises in Kisii County Kenya. A cross-section survey was conducted in Kisii County to collect primary data from a sample of 201 banana agripreneurs were selected using mult-stage sampling technique. A pre-tested semi-structured questionnaires were used to collect the data. Upon data collection, it was cleaned and analysed using descriptive statistics, double hurdle model and propensity score matching approach.

5.3 Conclusions

The following conclusions were drawn from empirical findings of this study

- i. Adopters of banana value addition were found to be young, produced more kilograms of bananas, lived further from the market, received more annual trainings and extension visits, engaged in farming, owned smaller farm sizes and did not have access to credit compared to non-adopters in Kisii County.
- ii. Decision to participate in banana value addition was positively and significantly influenced by group membership, distance from home to the output market, type of road networks (murrum), farming as the primary occupation, number of trainings and extension visits trainings contacts, extension visits. Moreover, marital status, farming experience, and access to credit had a negative significant effect on extent of adoption. However, extension visits and use of tarmac roads had a positive significant effect on extent of adoption of banana value addition
- iii. Banana value addition had a positive significant effect on profitability. Profits among adopters increased by KES 45,510.72 per acre.

5.4 Policy recommendations

- i. Agricultural extension organizations from private and public sectors should provide capacity building to small-scale banana agripreneurs as a way of empowering them through trainings, extension services, trade fairs and provision of incentives to increase the adoption rate and intensity of value addition in Kisii County.
- ii. Factors such as group memberships, and access to credit ought to be promoted by the national and County government among small-scale agripreneurs in Kisii County through sensitizing agripreneurs to form groups and cooperatives to enhance collective production, marketing, and acquiring of inputs. Addressing challenges of poor rural road networks should be put into consideration by the County government through allocating more funds to improve rural infrastructure in order to enhance access to markets and agricultural information. Also, through the County government, financial institutions should teach agripreneurs on the use of credit in value addition, explore credit inputs instead of cash loans and then monitor agripreneurs so that such credits are meant for improvement of banana value addition activities and not used for other agricultural or non-agricultural activities

- iii. Policy and decision makers in the government should formulate the policies that promote agripreneurs venturing into banana farming as a commercial enterprise. This could be achieved through provision of agribusiness management skills, improved banana varieties to increase crop yields which invoke value addition and improved access to processing and storage facilities. This would encourage small-scale agripreneurs to add more value to raw bananas for improved profitability.

5.5 Areas for further research

While this study only sought to characterize small-scale adopters and non-adopters of value addition among banana agripreneurs in Kisii County to determine the factors influencing adoption of banana value addition and to evaluate the effect of banana value addition on profitability among small-scale agripreneurs in Kisii County, Kenya. Future research is needed as follows:

- i. It may be important to carry out a similar study in other banana growing areas for comparison and more conclusive results
- ii. The future study should consider including other factors such as access to market information, income from other agricultural activities, access to electricity, ownership of assets, total livestock unit, farm record keeping, perceived relevance, level of awareness of banana value addition and other forms of banana value addition.
- iii. Finally, the future research should determine the factors influencing the choice of market outlets for banana value added products among small-scale agripreneur

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APPENDICES

Appendix A: Questionnaire

My name is Agnes Nyabwari Ntabo, pursuing Master of Science in Agri-enterprise Development at Egerton University. Research being a significant requirement for a student to graduate in our institution, I am conducting a study on *Effect of Utilization of Banana Value addition on performance of small-scale agrienterprises in Kisii County, Kenya*. The purpose of this study is purely academic. You have been selected to participate in this research survey. I kindly request you to allow me take a short time to ask you a number of questions in relation to my research. The information you provide shall be held strictly confidential.

Questionnaire Number-----

Sub-County ----- **Ward**-----

Name of Enumerator (Research assistant) -----**mobile**-----

Date----- **Starting time**----- **Finishing time**-----

A1. Demographic information

<p>A1. What is your gender? 1= Male 0= Female</p> <p>A2. What is your age in years</p> <p>A2. Who is the head of your household? 1. Self [] 2. Spouse [] 3. Others...</p>	<p>A3. What is your marital status? 1. Married 2. Single 3. Widowed 4. Divorced</p>	<p>A4. What is your highest level of education? 1.No formal education 2 primary level of education 3 Secondary level of education 4 Tertiary level of education</p>	<p>A5. What is your main source of income? 1.Farming 0. Others</p>
<p>A6. If yes, in A5 how much do you get in KES in a month</p> <p>A7 1. What crops do you grow a part from banana</p>	<p>A72. Which one gives you more income</p>	<p>A8. How many people live and eat with you in the house?</p>	<p>A9. How many of these people help you on the farm</p>

A. Information on banana Farming Characteristics

<p>A11. Total land size in acres</p> <ol style="list-style-type: none"> 1. Self-owned 2. Family 3. Rented 	<p>A13. If yes in A12 above, how many years have you been producing and selling bananas?</p> <p>A14. How many acres is under banana farming?</p> <p>A12. Do you grow bananas 1 yes 0 No</p>
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B1. Types of variable costs incurred in banana production

Type of variable cost	Unit of measurement	How many seasons do you apply/do in a year	Quantity used per season	Cost per unit per season	Total cost
Cost of Fertilizer					
Transport fare of fertilizer					
Labour application for fertilizer					
Cost of chemicals					
Transport cost of chemicals					
Labour cost of application for chemicals					
Cost of manure					
Transport cost of manure					
Cost of applying manure					

Labour cost of Weeding					
Labour cost of harvesting					

<p>B2 In what form do you sell bananas?</p> <ol style="list-style-type: none"> 1. Kgs 2. Fingers 3. Bunches <p>B3. What is the average kgs a bunch of bananas has</p>	<p>B4. where to you sell your bananas</p> <p>Farm gate Local Market</p> <p>B5. What is the price at farm gate per bunch per kgs</p> <p>At local market Per bunch Per Kgs</p>	<p>B6. What is the average price per bunch in KES during season of high demand?</p> <p>B7. What is the average price per bag in KES during season of high demand?</p>
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Banana value addition activities practised by banana agripreneurs

<p>B8. Are you aware of any of the following types of banana value addition?</p> <ol style="list-style-type: none"> 1 Cleaning sorting and grading, 2 Slicing and drying 3=frying crisps 4= wine making 5= flour milling, 6 Chapatti making, 6= Bread making 7=Scones making 8=jam and jelly making <p>How do you pack your crisps</p> <p>Grams or kilograms</p>	<p>B9. If yes in B8. Select the forms of value addition that you are practising?</p> <ol style="list-style-type: none"> 1 Cleaning sorting and grading, 2 Slicing and drying 3=frying crisps 4= wine making 5= flour milling, <p>B10 Do you sell your crisps in grams or kilograms or both?</p> <p>B11.What is the cost of one packing paper of crisps</p> <p>B12. How often do you produce crisps</p> <p>B12. How much do you produce?</p>
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B13 How many bunches are used in grading and packaging so that they can be sold	B14. How many bunches of bananas are used in slicing and drying so that they can be sold	B15 How many bunches or fingers are used to produce a litre of wine	B16 How many bunches of bananas are milled to make flour	B17. Baking	B18. How many fingers of bananas are used to produce 100 grams 8 crisps
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C1. What are the costs you incur for doing the following activities during value addition

cleaning, sorting and grading a bunch of bananas	
Peeling a bunch of bananas	
Labour in Spreading and drying	
Cost of milling a kilo of dried banana	
Tokens used to mill and how much per token	
Baking materials	
Cost of cooking oil for frying	
Tokens used for frying	
Cost of firewood use/charcoal used for frying	
Cost of labour for frying crisps	
Cost of Packaging materials	

C2. How much do you sell your products after value addition per unit

Final product	Price per kgs
Crisps	
Dried banana	
Banana Flour	
Cleaned and graded banana	
Wine (per ml)	

<p>C3 Where to you sell your products</p> <ol style="list-style-type: none"> 1. Local schools 2. Local hotels 3. Local shops 4. Farmgate 5. Field days 6. Contracted company 7. Open air markets (vibandas/road sides) 8. Supermarkets <p>9 Others</p>	<p>C 4 Are you having a contract with other people like buyers</p> <p>1 Yes 2 No</p> <p>How is the trust between you and those people</p> <p>1 Low 2 High</p> <p>Training</p> <p>Have you received a training on banana value addition in the last one year</p> <p>1=Yes 2=No</p> <p>If yes, how many? <i>If no proceed to B</i></p>
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B. Other transaction cost incurred during marketing

Activity	Option	Amount incurred
Do you negotiate with your customers (time taken)	1 yes 2. No	
Do you pay any amount once you are in the market? (<i>Ogochugwa</i>)	1 Yes 2 No	
Do you look for a customer who can buy your produce	1 Yes 2 No	
What cost incur cost for storage	1Yes 2 No	

Institutional factors

Do you belong to any group, 1= Yes 2=No
If yes, what how many groups do you belong in? 1. Marketing Association/group 2. Women Group 3. Community Based Organization 4. Cooperative/SACCO 5. Merry Go Round group 6. Others (Specify), How long have you been a member in the group(s)?
What benefits do you get from the group 1. Collective farming and marketing 2. Access to Credit 3. Access to Information 4. Access to extension services 5. Trainings including aspects of better value addition 6. Others. (Specify).....
Have you ever received extension services in the last one year? 1= Yes [] 2=No []
If yes in the question above, how many times did you receive in that year []

<p>Where do you obtain technical information on banana farming? 1. Farmer groups 2. Radio 3. Television 5. Extension worker 6. NGO organizations 7 others</p>
<p>What are the challenges you are facing if you are a non- value adder? What are the challenges you are facing if you are a value adder?</p>
<p>Have you ever acquired any credit in cash or in kind in the last one year? 1= Yes 2= No If Yes, and in cash, what was the approximate amount borrowed? (Kes)_____</p> <p>If in Kind, what was it and what is the value of it?.....</p> <p>If in kind, where did you obtain it from, 1National government,2 Count government,3 NGOs 4 World bank</p>
<p>What was your reason for borrowing the CREDIT? 1. Buy value addition equipment 2. Buy production inputs 3. Medical bills 4. School fees 5 specify others</p>
<p>What was the source of the credit advanced in Cash? 1. Commercial banks 2. SACCO 3. Microfinance institutions 4. Informal lenders/Groups 5. Farmer group 6 Others</p>
<p>If yes, and in cash how much did you use in banana farming (KES)</p>
<p>If No, give reason why you did not borrow credit (please tick one that is most applicable) 1. No collateral 2. Defaulted on previous loan 3. High interest rate 4. Not aware of credit facilities 5. Others (Specify)_____</p>
<p>Do you participate in off farm income? 1= Yes 2= No If yes, how much do you get from off farm activities per month (KES) per month? [What challenges are you facing since you started adding value? What do you recommend the government to help you in promoting banana value addition</p>

Appendix B: Contingent coefficient test for categorical explanatory variables used in DH model

```
. pwcorr Gender Primary_Level Secondary_Level Tertiary_Level Marital_Status Murram_Road Tarma
> c_Road Main_occup Grp_Membership Access_Credit
```

	Gender	Primar~l	Second~l	Tertia~l	Marita~s	Murram~d	Tarmac~d
Gender	1.0000						
Primary_Le~l	-0.0304	1.0000					
Secondary_~l	-0.0597	-0.5223	1.0000				
Tertiary_L~l	0.1873	-0.3136	-0.4138	1.0000			
Marital_St~s	-0.0623	0.0924	0.0588	-0.1573	1.0000		
Murram_Road	-0.0772	-0.0395	-0.0326	0.0574	-0.0015	1.0000	
Tarmac_Road	-0.0345	0.0494	-0.0832	0.0976	-0.0411	-0.3673	1.0000
Main_occup	-0.0948	0.2519	-0.0016	-0.3679	0.1822	0.2153	-0.1105
Grp_Member~p	-0.0582	0.0438	0.0316	0.0151	-0.0151	0.1079	0.0290
Access_Cre~t	-0.0487	0.0104	-0.1205	0.0881	-0.0628	-0.0388	0.1173

	Main_o~p	Grp_Me~p	Access~t
Main_occup	1.0000		
Grp_Member~p	-0.0415	1.0000	
Access_Cre~t	0.0055	0.1646	1.0000

Appendix C: DH model analysis for objective 2

Estimating Cragg's tobit alternative
Assumes conditional independence

```

initial:      log pseudolikelihood =      -<inf> (could not be evaluated)
feasible:    log pseudolikelihood = -220.41137
rescale:     log pseudolikelihood =  84.925577
rescale eq:  log pseudolikelihood = 143.81433
Iteration 0: log pseudolikelihood = 143.81433 (not concave)
Iteration 1: log pseudolikelihood = 209.37062 (not concave)
Iteration 2: log pseudolikelihood = 244.03357 (not concave)
Iteration 3: log pseudolikelihood = 249.93011
Iteration 4: log pseudolikelihood = 260.87063
Iteration 5: log pseudolikelihood = 268.43059
Iteration 6: log pseudolikelihood = 269.20314
Iteration 7: log pseudolikelihood = 269.36132
Iteration 8: log pseudolikelihood = 269.38307
Iteration 9: log pseudolikelihood = 269.38361
Iteration 10: log pseudolikelihood = 269.38362

```

```

Number of obs =   201
Wald chi2(17) =  65.38
Prob > chi2   =  0.0000

```

Log pseudolikelihood = 269.38362

	Coefficient	Robust std. err.	z	P> z	[95% conf. interval]	
Tier1						
Gender	-.0258131	.3710675	-0.07	0.945	-.753092	.7014658
Primary_Level	-.7053085	.5382962	-1.31	0.190	-1.76035	.3497327
Secondary_Level	.504892	.5763817	0.88	0.381	-.6247954	1.634579
Tertiary_Level	1.0772	.7768921	1.39	0.166	-.445481	2.59988
Marital_Status	-.1790324	.4417544	-0.41	0.685	-1.044855	.6867903
Main_occup	1.99233	.5172711	3.85	0.000	.9784972	3.006163
Hh_size	-.0202203	.1282302	-0.16	0.875	-.271547	.2311063
Age	.0035213	.0179217	0.20	0.844	-.0316046	.0386472
Farm_Size	-.3933132	.2942438	-1.34	0.181	-.9700203	.183394
OUTPUTPRO	.1730069	.0982076	1.76	0.078	-.0194765	.3654904
No_Train	.5395301	.1258556	4.29	0.000	.2928577	.7862026
Dist_Mkt	.2126597	.0848667	2.51	0.012	.046324	.3789953
Murram_Road	2.951111	.5195928	5.68	0.000	1.932727	3.969494
Tarmac_Road	-.0889699	.4585884	-0.19	0.846	-.9877866	.8098468
Grp_Membership	1.032617	.65132	1.59	0.113	-.2439468	2.309181
Access_Credit	-.5627778	.3576238	-1.57	0.116	-1.263708	.138152
Ext_contact	.75577	.2797724	2.70	0.007	.2074262	1.304114
_cons	-7.707127	1.975705	-3.90	0.000	-11.57944	-3.834817
Tier2						
Gender	-.0111506	.0088286	-1.26	0.207	-.0284543	.0061531
Primary_Level	.0155003	.0113425	1.37	0.172	-.0067305	.0377311
Secondary_Level	.0215182	.0149224	1.44	0.149	-.0077292	.0507656
Tertiary_Level	.0215077	.0188661	1.14	0.254	-.0154691	.0584845
Marital_Status	-.0164104	.0072304	-2.27	0.023	-.0305817	-.0022391
Main_occup	.0092894	.0087835	1.06	0.290	-.007926	.0265048
Hh_size	.0000745	.0024874	0.03	0.976	-.0048007	.0049497
Age	.0010588	.0007648	1.38	0.166	-.0004401	.0025578
Farm_Size	-.0023536	.0051147	-0.46	0.645	-.0123782	.007671
OUTPUTPRO	.0072122	.0027966	2.58	0.010	.0017309	.0126934
No_Train	.0027903	.0037249	0.75	0.454	-.0045105	.010091
Dist_Mkt	.0008353	.0013727	0.61	0.543	-.0018551	.0035257
Murram_Road	.007482	.0107807	0.69	0.488	-.0136478	.0286118
Tarmac_Road	.0330384	.0125758	2.63	0.009	.0083902	.0576866
Grp_Membership	.0315506	.0286021	1.10	0.270	-.0245086	.0876098
Access_Credit	-.0190867	.0109783	-1.74	0.082	-.0406039	.0024304
Ext_contact	.0083356	.0032688	2.55	0.011	.0019288	.0147423
Farm_Exp	-.001157	.0006513	-1.78	0.076	-.0024334	.0001195
off_farm_income	-.0007205	.0008657	-0.83	0.405	-.0024172	.0009761
_cons	-.1487612	.0800213	-1.86	0.063	-.3056001	.0080777
sigma						
_cons	.0102753	.0021816	4.71	0.000	.0059996	.0145511

Appendix D: Probit model for estimating propensity scores in PSM model

```
. probit valueaddition Kgs_hvsted i.Gender Age i.EducLev Hh_size i.Offfarm_Actvy Farm_Exp Ac
> res_Owned Bana_Acres i.Extent_Ac i.Grp_Membership i.Marital Dist_Mkt No_Train, robust
```

```
Iteration 0: log pseudolikelihood = -123.37104
Iteration 1: log pseudolikelihood = -73.564389
Iteration 2: log pseudolikelihood = -71.284235
Iteration 3: log pseudolikelihood = -71.214124
Iteration 4: log pseudolikelihood = -71.2141
Iteration 5: log pseudolikelihood = -71.2141
```

Probit regression

```
Number of obs = 201
Wald chi2(16) = 75.60
Prob > chi2 = 0.0000
Pseudo R2 = 0.4228
```

Log pseudolikelihood = -71.2141

valueaddition	Robust		z	P> z	[95% conf. interval]	
	Coefficient	std. err.				
Kgs_hvsted	.0000129	.0000197	0.65	0.514	-.0000258	.0000515
Gender						
Male	.2432588	.2453715	0.99	0.321	-.2376606	.7241781
Age	-.0308772	.0203586	-1.52	0.129	-.0707794	.009025
EducLev						
Pimary	-.9799683	.4130084	-2.37	0.018	-1.78945	-.1704866
Secondary	-.3678425	.3664421	-1.00	0.315	-1.086056	.3503708
Tertiary	-.2365047	.4492756	-0.53	0.599	-1.117069	.6440593
Hh_size	-.0281298	.0738693	-0.38	0.703	-.172911	.1166514
Offfarm_Actvy						
Yes	-.2938444	.2491728	-1.18	0.238	-.7822142	.1945253
Farm_Exp	.0256637	.0261622	0.98	0.327	-.0256133	.0769407
Acres_Owned	-.2605221	.2043143	-1.28	0.202	-.6609706	.1399265
Bana_Acres	.2477562	.5525568	0.45	0.654	-.8352351	1.330748
Extent_Ac						
Yes	.484023	.3982321	1.22	0.224	-.2964975	1.264544
Grp_Membership						
Yes	.9499353	.550041	1.73	0.084	-.1281253	2.027996
Marital						
Married	-.1256212	.2615755	-0.48	0.631	-.6382998	.3870574
Dist_Mkt	.2491187	.068973	3.61	0.000	.1139342	.3843033
No_Train	.4885038	.0876047	5.58	0.000	.3168018	.6602058
_cons	-2.614706	1.078193	-2.43	0.015	-4.727925	-.5014865

Appendix E: PSM using kernel bandwidth (0.25)

```
. use "G:\My Drive\SPSS OUTPUTS\Propensity Score STATA data.dta"

. psmatch2 valueaddition Kgs_hvsted i.Gender Age i.EducLev Hh_size Farm_Exp Acres_Owned i.Extent
> _Ac i.Grp_Membership i.Marital Dist_Mkt No_Train , out ( MGross_Margin_Peracre ) kernel bwidth
> (0.25) ate common
```

```
Probit regression                               Number of obs =    201
                                                LR chi2(14)    = 102.98
                                                Prob > chi2    = 0.0000
                                                Pseudo R2     = 0.4174

Log likelihood = -71.880117
```

valueaddition	Coefficient	Std. err.	z	P> z	[95% conf. interval]	
Kgs_hvsted	.0000181	.0000149	1.21	0.227	-.0000112	.0000474
Gender						
Male	.2226306	.2805043	0.79	0.427	-.3271478	.7724089
Age	-.0297659	.0212957	-1.40	0.162	-.0715047	.0119728
EducLev						
Primary	-1.084284	.5179808	-2.09	0.036	-2.099508	-.0690605
Secondary	-.4035089	.4581095	-0.88	0.378	-1.301387	.4943693
Tertiary	-.3161268	.5044582	-0.63	0.531	-1.304847	.6725932
Hh_size	-.0415674	.0770532	-0.54	0.590	-.1925889	.1094542
Farm_Exp	.0257288	.0270634	0.95	0.342	-.0273146	.0787721
Acres_Owned	-.2223953	.198992	-1.12	0.264	-.6124124	.1676219
Extent_Ac						
Yes	.4932017	.6085845	0.81	0.418	-.699602	1.686005
Grp_Membership						
Yes	.8646622	.6268096	1.38	0.168	-.363862	2.093186
Marital						
Married	-.0601312	.3027406	-0.20	0.843	-.6534918	.5332294
Dist_Mkt	.2453179	.0533261	4.60	0.000	.1408006	.3498352
No_Train	.487512	.1008216	4.84	0.000	.2899053	.6851187
_cons	-2.621734	1.218817	-2.15	0.031	-5.010571	-.2328971

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
MGross_Margin_~e	Unmatched	70158.5764	17455.9307	52702.6457	4857.28797	10.85
	ATT	74160.7696	28650.0461	45510.7235	7961.82581	5.72
	ATU	20010.8225	64570.296	44559.4736	.	.
	ATE			44923.782	.	.

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support		Total
	Off suppo	On suppor	
Untreated	53	87	140
Treated	7	54	61
Total	60	141	201

```
. pstest valueaddition Kgs_hvsted i.Gender Age i.EducLev Hh_size Farm_Exp Acres_Owned i.Extent_A
> c i.Grp_Membership i.Marital Dist_Mkt No_Train , both
```

Variable	Unmatched Matched	Mean		%reduct %bias	t-test		V(T)/ V(C)
		Treated	Control		t	p> t	

```
. pstest Kgs_hvsted i.Gender Age i.EducLev Hh_size Farm_Exp Acres_Owned i.Extent_Ac i.Grp_Membe
> rship i.Marital Dist_Mkt No_Train , both
```

Variable	Unmatched Matched	Mean		%reduct		t-test		V(T)/ V(C)
		Treated	Control	%bias	bias	t	p> t	
Kgs_hvsted	U	10196	6846.2	40.5		2.58	0.011	0.78
	M	9854.4	10477	-7.5	81.4	-0.31	0.759	0.37*
1.Gender	U	.37705	.5	-24.8		-1.61	0.109	.
	M	.38889	.47742	-17.9	28.0	-0.92	0.358	.
Age	U	45.049	49.929	-38.3		-2.42	0.017	0.70
	M	45.778	45.546	1.8	95.2	0.10	0.922	0.76
2.EducLev	U	.22951	.30714	-17.5		-1.12	0.264	.
	M	.2037	.16215	9.4	46.5	0.55	0.581	.
3.EducLev	U	.44262	.39286	10.0		0.66	0.512	.
	M	.48148	.56716	-17.3	-72.2	-0.89	0.377	.
4.EducLev	U	.21311	.19286	5.0		0.33	0.742	.
	M	.22222	.20839	3.4	31.7	0.17	0.863	.
Hh_size	U	5.0164	5.4429	-25.2		-1.64	0.102	1.01
	M	4.9444	5.1764	-13.7	45.6	-0.72	0.471	1.17
Farm_Exp	U	20.787	22.536	-17.8		-1.17	0.245	1.03
	M	21.148	20.787	3.7	79.3	0.19	0.848	1.03
Acres_Owned	U	1.5451	1.7957	-33.6		-2.14	0.033	0.81
	M	1.5833	1.7039	-16.1	51.9	-0.77	0.445	0.58*
1.Extent_Ac	U	.96721	.84286	43.2		2.53	0.012	.
	M	.96296	.98793	-8.7	79.9	-0.83	0.407	.
1.Grp_Membership	U	.96721	.85714	39.5		2.32	0.022	.
	M	.96296	.96424	-0.5	98.8	-0.04	0.972	.
1.Marital	U	.78689	.80714	-5.0		-0.33	0.742	.
	M	.75926	.76512	-1.4	71.1	-0.07	0.944	.
Dist_Mkt	U	7.2131	4.5596	105.1		7.08	0.000	1.38
	M	6.7037	6.0102	27.5	73.9	1.47	0.143	0.63
No_Train	U	3.2295	1.5643	133.0		8.34	0.000	0.66
	M	3.037	3.1504	-9.1	93.2	-0.53	0.598	0.69

* if variance ratio outside [0.60; 1.67] for U and [0.58; 1.72] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.417	102.98	0.000	38.5	29.4	184.7*	0.68	0
Matched	0.030	4.49	0.992	9.9	8.9	41.0*	1.27	29

* if B>25%, R outside [0.5; 2]

```
. psgraph
```

Appendix F: PSM using radius caliper (0.1)

```
. psmatch2 valueaddition Kgs_hvsted i.Gender Age i.EducLev Hh_size Farm_Exp Acres_Owned i.Extent
> _Ac i.Grp_Membership i.Marital Dist_Mkt No_Train , out ( MGross_Margin_Peracre ) radius calipe
> r(0.1) ate common
```

```
Probit regression                               Number of obs =    201
                                                LR chi2(14)    = 102.98
                                                Prob > chi2    = 0.0000
Log likelihood = -71.880117                    Pseudo R2      = 0.4174
```

valueaddition	Coefficient	Std. err.	z	P> z	[95% conf. interval]	
Kgs_hvsted	.0000181	.0000149	1.21	0.227	-.0000112	.0000474
Gender						
Male	.2226306	.2805043	0.79	0.427	-.3271478	.7724089
Age	-.0297659	.0212957	-1.40	0.162	-.0715047	.0119728
EducLev						
Pimary	-1.084284	.5179808	-2.09	0.036	-2.099508	-.0690605
Secondary	-.4035089	.4581095	-0.88	0.378	-1.301387	.4943693
Tertiary	-.3161268	.5044582	-0.63	0.531	-1.304847	.6725932
Hh_size	-.0415674	.0770532	-0.54	0.590	-.1925889	.1094542
Farm_Exp	.0257288	.0270634	0.95	0.342	-.0273146	.0787721
Acres_Owned	-.2223953	.198992	-1.12	0.264	-.6124124	.1676219
Extent_Ac						
Yes	.4932017	.6085845	0.81	0.418	-.699602	1.686005
Grp_Membership						
Yes	.8646622	.6268096	1.38	0.168	-.363862	2.093186
Marital						
Married	-.0601312	.3027406	-0.20	0.843	-.6534918	.5332294
Dist_Mkt	.2453179	.0533261	4.60	0.000	.1408006	.3498352
No_Train	.487512	.1008216	4.84	0.000	.2899053	.6851187
_cons	-2.621734	1.218817	-2.15	0.031	-5.010571	-.2328971

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
MGross_Margin_~e	Unmatched	70158.5764	17455.9307	52702.6457	4857.28797	10.85
	ATT	74160.7696	28709.6711	45451.0984	8114.53217	5.60
	ATU	20010.8225	62679.9533	42669.1309	.	.
	ATE			43734.5652	.	.

Note: S.E. does not take into account that the propensity score is estimated.

psmatch2: Treatment assignment	psmatch2: Common support		Total
	Off suppo	On suppor	
Untreated	53	87	140
Treated	7	54	61
Total	60	141	201

```
. pstest Kgs_hvsted i.Gender Age i.EducLev Hh_size Farm_Exp Acres_Owned i.Extent_Ac i.Grp_Membe
> rship i.Marital Dist_Mkt No_Train , both
```

Variable	Unmatched Matched	Mean		%reduct		t-test		V(T)/ V(C)
		Treated	Control	%bias	bias	t	p> t	
Kgs_hvsted	U	10196	6846.2	40.5		2.58	0.011	0.78
	M	9854.4	10260	-4.9	87.9	-0.20	0.842	0.37*
1.Gender	U	.37705	.5	-24.8		-1.61	0.109	.
	M	.38889	.43767	-9.8	60.3	-0.51	0.611	.
Age	U	45.049	49.929	-38.3		-2.42	0.017	0.70
	M	45.778	45.632	1.1	97.0	0.06	0.950	0.84
2.EducLev	U	.22951	.30714	-17.5		-1.12	0.264	.
	M	.2037	.17718	6.0	65.8	0.35	0.729	.
3.EducLev	U	.44262	.39286	10.0		0.66	0.512	.
	M	.48148	.58301	-20.5	-104.0	-1.05	0.295	.
4.EducLev	U	.21311	.19286	5.0		0.33	0.742	.
	M	.22222	.18854	8.3	-66.3	0.43	0.668	.
Hh_size	U	5.0164	5.4429	-25.2		-1.64	0.102	1.01
	M	4.9444	5.2294	-16.8	33.2	-0.89	0.374	1.19
Farm_Exp	U	20.787	22.536	-17.8		-1.17	0.245	1.03
	M	21.148	21.267	-1.2	93.2	-0.06	0.949	1.08
Acres_Owned	U	1.5451	1.7957	-33.6		-2.14	0.033	0.81
	M	1.5833	1.6439	-8.1	75.8	-0.38	0.701	0.58*
1.Extent_Ac	U	.96721	.84286	43.2		2.53	0.012	.
	M	.96296	.98968	-9.3	78.5	-0.91	0.366	.
1.Grp_Membership	U	.96721	.85714	39.5		2.32	0.022	.
	M	.96296	.96989	-2.5	93.7	-0.20	0.843	.
1.Marital	U	.78689	.80714	-5.0		-0.33	0.742	.
	M	.75926	.78823	-7.2	-43.0	-0.36	0.722	.
Dist_Mkt	U	7.2131	4.5596	105.1		7.08	0.000	1.38
	M	6.7037	6.1484	22.0	79.1	1.14	0.258	0.56*
No_Train	U	3.2295	1.5643	133.0		8.34	0.000	0.66
	M	3.037	3.2642	-18.1	86.4	-1.06	0.294	0.68

* if variance ratio outside [0.60; 1.67] for U and [0.58; 1.72] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.417	102.98	0.000	38.5	29.4	184.7*	0.68	0
Matched	0.030	4.56	0.991	9.7	8.2	41.1*	1.18	43

* if B>25%, R outside [0.5; 2]

Appendix G: Ethical clearance from Egerton University

EGERTON

TEL: (051) 2217808
FAX: 051-2217942



UNIVERSITY

P. O. BOX 536
EGERTON

**EGERTON UNIVERSITY INSTITUTIONAL SCIENTIFIC AND ETHICS
REVIEW COMMITTEE**

EU/RE/DIR/009

Approval No. EUISERC/APP/220/2023

23rd February, 2023

Agnes Nyabwari Ntibo
Egerton University
Address: 536-20115
Telephone: +254719171333
E-mail: ntaboagnes47@gmail.com

Dear Agnes,

**RE: ETHICAL APPROVAL: UPTAKE AND EFFECT OF BANANA (*Musa SPP.*)
VALUE ADDITION ON PERFORMANCE OF SMALL-SCALE AGRI-ENTERPRISES
IN KISII COUNTY, KENYA**

This is to inform you that *Egerton University Institutional Scientific and Ethics Review Committee* has reviewed and approved your above research proposal. Your application approval number is *EUISERC/APP/220/2023*. The approval period is *23rd February, 2023 –24th February, 2024*.

This approval is subject to compliance with the following requirements;

- i. Only approved documents including (informed consents, study instruments, MTA) will be used.
- ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by *Egerton University Institutional Scientific and Ethics Review Committee*.
- iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to *Egerton University Institutional Scientific and Ethics Review Committee* within 72 hours of notification
- iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be

"Transforming Lives through Quality Education"

Appendix H: Research permit

 REPUBLIC OF KENYA	 NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION
RefNo: 681105	Date of Issue: 04/April/2023
RESEARCH LICENSE	
	
<p>This is to Certify that <u>Ms. Agnes Nyabwari Ntabo</u> of Egerton University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kisii on the topic: <u>Effect of utilization of banana value addition on performance of small-scale agri-enterprises in Kisii County, Kenya.</u> for the period <u>ending: 04/April/2024.</u></p>	
License No: NACOSTI/P/23/24647	
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	Verification QR Code
	
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See overleaf for conditions	

Appendix I: Summary of gross margin analysis to determine profitability

variable	Value adders (n= 61)		Non-value adders (n= 140)		t- value	p-value
	Mean	SD	Mean	SD		
Total revenue (KES/Acre)	214,987.50	63,456.72	39211.31	678.92	-12.11	0.06*
Cost of buying manure (KES/Acre)	9,201.06	4,951.45	7,560.44	6,487.82	-1.76	0.08*
Manure application cost (KES/Acre)	642.73	349.05	510.52	472.44	-1.96	0.51
Cost of Weeding (KES/Acre)	1,227.61	579.98	459.25	293.76	-12.46	0.00***
Cost of Harvesting (KES/Acre)	10,247.55	6,401.77	6,164.81	5,081.51	-4.12	0.00***
Cost of transport (KES/Acre)	29,954.62	46,170.48	6,325.25	15,020.64	-5.44	0.00***
Marketing cost (KES/Acre)	501.72	1,205.60	735.11	1,558.26	1.04	0.39
Storage cost (KES/Acre)	7,937.45	7,675.78	0	0	-12.28	0.00***
Value addition cost (KES/Acre)	85,116.18	110,273.90	0	0	-9.16	0.00***
Total variable Cost (KES/Acre)	144,828.92	87,035.12	21,755.38	15,401.01	-2.44	0.00***
Gross Margin (KES/Acre)	70,158.58	4,857.29	17,455.93	4857.29	10.85	0.05**

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Economics

Full Length Research Paper

Determinants of utilization of banana value addition among small-scale agripreneurs in Kenya: A case of Kisii County

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There is an increased demand for banana fruit and its processed products among both rural and urban populations. Value addition has the potential to reduce postharvest losses, increase crop productivity, and enhance crop income. Despite the promotion of banana value addition by government and non-governmental organizations, its utilization remains low in Kisii county, Kenya. There is a lack of information on the determinants of the utilization of banana value addition. Previous studies on determinants of crop value addition have primarily focused on tomatoes, mangoes, tubers and root crops, with limited emphasis on banana fruit. This knowledge gap necessitated the current study. A multi-stage sampling procedure was employed to select 201 respondents. Data were collected using semi-structured questionnaires and analyzed using descriptive and inferential statistics, as well as Cragg's Double Hurdle model. The results revealed that banana value adders were involved in various activities such as flour milling (36%), slicing and drying (31%), cleaning, sorting and grading (26%), and crisps making (7%). In comparison to non-value adders, value adders were significantly younger, produced larger quantities of bananas, travelled longer distances to the market, received more training and extension visits, considered farming as their main occupation, owned smaller farm sizes, and the majority did not have access to credit. The decision to utilize banana value addition was significantly influenced by the total quantity of bananas produced, the type of roads, primary occupation, the number of training sessions and extension contacts, distance to the output market, group membership, and access to credit. The extent of value addition was influenced by extension contacts, type of roads, total quantity of bananas produced, and marital status (being married). The study recommends that socioeconomic and institutional factors influencing both the decision and extent of banana value addition should be considered when formulating and implementing policies aimed at promoting banana value addition.

Key words: Agripreneurs, banana, double hurdle, utilization, value addition.