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Assessing psycho-social, socioeconomic and institutional characteristics that influence adoption of climate smart agriculture in Taita Taveta County, Kenya

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Assessing Psycho-Social, Socioeconomic and Institutional Characteristics that Influence Adoption of Climate Smart Agriculture in Taita Taveta County, Kenya.

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Declaration

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the dissertation contains no material previously published or written by another person except where due reference is made in the dissertation itself.

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Abstract

Adoption of Climate Smart Agriculture practices remains key policy agenda in Kenya especially in the wake of climate change and increased food insecurity. This research adopted an integrative approach in examining how psycho-social, socioeconomic and institutional characteristics influence adoption of Climate Smart Agriculture (CSA) in Taita Taveta County, Kenya. The study applied the Theory of Planned Behaviour theoretical framework with Multivariate Probit Modelling and Structural Equation Modeling in assessing small holder farmer's adoption decisions making process to CSA. The study showed there is no significant difference between, socioeconomic, institutional characteristics and adoption of Climate Smart Agriculture practices. Socioeconomic characteristics such as farm income; farmer group membership were found to increase the probability of adoption of CSA. While Institutional characteristics such as extension service, input subsidies and national government support also increase the likelihood of adoption rate among small holder farmers. The result further showed that farmer's perceived behavioral control and personal attitudes significantly influence, the farmer intention to adopt a number of CSA practices within the household.

These results mean that efforts to promotes adoption of Climate Smart Agriculture practices should concentrate on empowering farmers through support and resources mobilization to increase farm income, access to quality extension service, institutional support and general improvement of farmer's awareness and knowledge to change their perception and attitude towards adoption of climate smart agriculture.

Key words: Psycho-social, Socioeconomic, Institutional, Productivity, Adoption, Adaptation, Mitigation, Climate Change, Climate Smart Agriculture

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I would also like to acknowledge the County Government of Taita Taveta who permitted me to conduct research in the county and all respondents who sacrificed their time and shared information freely despite the fact that data was collected during planting season.

Finally, I am grateful to my family, specifically my wife Lilian Mwasaru who critiqued and edited my work; and my children for their encouragement. Lastly am forever thankful to God for according me physical and mental health that enable me take on this research project to its final conclusion.

DEDICATION

This work is dedicated to my family, My parents, the Late. Mr. Paul Mwaghania and Mrs Frida Mwaghania, who saw education as a non-negotiable tool in my life that I had to get no matter the cost. To my wife, Mrs. Lilian Maigo Mwasaru, for her support and assurance and challenging me to take up the course despite tough economic times. Lastly to our children: Frida, Regina, Rita, Emmanuel and their cousin Wilkister for cheering me on. You are a special team.

CHAPTER ONE

INTRODUCTION

1.2 Background of the study

Climate Smart Agriculture is gaining traction at global and national level to meet challenges of addressing agricultural productivity and planning under climate change. CSA seek to achieve sustainable agriculture development for food security under new realities of climate change impact (Lipper et al., 2014). Climate change has not only affected agriculture sector but also other sectors of the economy, hence suitable sustainable agricultural production systems needs to be adopted to increase productivity, adaptation or resilience and mitigate components that reduce GHG and emission of CO_2 to the environment. Hulme et al.(2001) and Intergovernmental Panel on Climate Change (Solomon et al., 2007) have both projected warmer global temperatures, rainfall drop of between 5-20% during the months of December to February and 5-10% less precipitation in June to August by 2050 in East Africa.The cereal biomass for livestock and crops yields is also expected to drop by 20% FAO (2010). The increase in warmer temperature will result in declined food production hence putting agriculture at risk.

Compounded by the fact that Africa population is projected to double by 2050 and quadruple by 2100. This means a drive to food production is needed to cater for these growing population at the same time protect the fragile environment through which agriculture production takes place and thrives. However, though the food security will be solved by agriculture, the same agriculture is the main contributor to land degradation, deforestation and carbon emissions. In order to increase productivity in agriculture sector at the same time reduce the effects of climate change on food security, the U.N Food and Agriculture Organization(FAO) has pledged to improve " the way we manage agricultural systems and natural resources" with Climate Smart Agriculture (CSA) Kako, (2014). Climate Smart Agriculture as defined by FAO, 2010 is an approach that integrates three dimensions of sustainable development (economic, social and environment) by jointly addressing food security and climatic challenges. It encompasses three main pillars: sustainable increasing agricultural productivity, adopting and building resilience to climate change and lastly reducing and or removing greenhouse gas emissions where possible. CSA is not a single agricultural technology or practice that can universally be applied but it's an approach that requires site specific assessment to identify suitable agricultural production technologies and practices that can give the best results within the context of the three main pillars.

While Success of CSA projects have been implemented and well documented with positive results, numerous factors constrain the adoption, up-scaling and effectiveness of CSA. (McCarthy et al., 2011) argues that there are institutional barriers to the adoption and upscaling of CSA technologies and practices. The systematic literature review of concepts and context of CSA, discourse in academic papers, policy literature, documents, related CSA peer reviewed journals, books and scientific papers from 2004 to 2016, (Chandra et al., 2017) suggest that new research in CSA should focus more on cross–disciplinary aspects that underpin broad socioeconomic, adoption and political contest covering a wide geographical region and not solely on scientific approaches targeting small scale farmers and developing countries, but also focus on large scale farmers and developed countries.

Despite the significant global action and investment in Climate-Smart Agriculture, there is scant evidence of what technologies and practices work, where and why, what the synergies and trade-offs are, among the three main pillars of Climate-Smart Agriculture (productivity, adaptation and mitigation), and what successful scaling mechanisms (including financial services) are, that can generate a transformation of agriculture and mitigate climate change.

In recent time, Kenya has had its share of climate related variability, that include impacts of prolonged droughts, frost in some of the agriculture production zones, hailstorms, extreme flooding, rescinding and recharging of lake levels, drying rivers and wetlands among others, leading to huge economic losses and adversely impacting food security, livelihoods and communities (Research Institute (IFPRI), 2013). To counter this emerging climate change issue in the face of increased food demand and population increase, Kenya has developed a national Climate Smart Agriculture program 2015-2030 which acknowledges that CSA will play a critical role in increasing food productivity, enhancing adaptation and resilience of Kenya's farming system while reducing emissions in order to achieve suitable sustainable development and reduce poverty (GoK 2013).

A study by FAO on policies, program, projects and activities on CSA in Kenya shows that some of the CSA practices being undertaken by farmers include improved livestock breeds, crop diversification, mixed cropping, tree planting, irrigation and diversification of livelihoods and enhancing early warning systems with drought monitoring and seasonal forecast (Osumba & Rioux, 2015) The study called for an in depth understanding of the political, economic, environmental and social cultural factors that might influence the uptake of CSA practices in Kenya and at the local scale. Participatory, social learning process, linking community

knowledge with that of science can also be used to address the uncertainties inherent in agriculture context and also with changing climate.

While reviewing the uptake of Climate Smart Agriculture through gender inter-sectional lens in Western Kenya, (C. Mungai et al, 2017) reveals that farmers regardless of gender are willing to adopt Climate Smart Technologies and practices, however factors such as ethnicity, education, age and marital status, determine the level of uptake of Climate Smart Agriculture technologies and practices.

1.3 Problem Statement

Agriculture has been cited as the main contributor to climate change at the same time the main contributor to food security. The relationship between climate change and agriculture is bi-directional: Agriculture contributes to climate change and in turn is affected by climate change. Agriculture contributes to global warming though emission of greenhouse gases (GHGs) (crops and livestock production and by conversion of non-agricultural land into agricultural land).
Climate change on the other hand is one of the limiting factors to agricultural production and threatens to exacerbate existing threat to food security and livelihoods in a number of ways including reduced crop yield, increasing frequency and intensity of extreme events like heat waves, droughts, food stress in livestock, increase in pests and diseases and increase in water scarcity (IPCC 2007). (Makate, 2019)confirms that a wide range of potential agricultural farming systems like CSA have been introduced and documented to address agriculture and climate change, however the adoption is low and he further notes that effective adoption of Climate Smart Agriculture in Sub-Saharan Africa among smallholder farmers is lagging behind despite its demonstrated effectiveness in the face of increased population, increased food insecurity and adverse climate change. These technologies which include mixed farming, crop rotation, crop improvements, minimum tillage, water harvesting, interim of breeds, government interventions such as agriculture farm input subsidies like fertilizer and seeds, farmer insurance schemes and irrigation schemes are effective in increasing productivity, improving resilience and reducing GHG emissions. However, their adoption by small holder farmers is very low, even with the support and intervention from various institutions (GoK 2016). Most of the empirical studies have generally focused on the economic factors influencing adoption of CSA while fewer studies have been done to understand small holder farmers behaviour and their willingness to invest in new technologies like CSA and the intrinsic factors influencing farmers conservation behaviour (Meijer et al., 2015). The behavioral approach has pointed out the inadequacy of the traditional economic approaches to

understand farmers conservation behaviour, particularly given that conservation related practices are not always made on the economical rational basis (Wauters, 2006). There are suggestions that non-economical and intrinsic factors like farmer's attitude, subjective norms and perceived controlled behaviour may influence the intentions of individual decision making process. Therefore, interventions to promote CSA must target the changing farmers behaviour (Schultz, 2011). Developing a clear pitch on the drivers, barriers and processes shaping the adoption and uptake of CSA therefore requires a strong understanding of the psycho-social factors influencing farmer's willingness to adopt Climate Smart Agricultural practices and the socioeconomic and institutional factors affecting the farmer's ability to adopt these technologies in their farms.

1.3.1 Taita Taveta County

Taita Taveta County found in the Coastal part of Kenya, covers a land area of 17,084 square kilometers, of which 62% (11,100 square km) is under the Tsavo National Parks, that is Tsavo East and Tsavo West National Parks. The remaining 38% (5,984 square km) consists of small scale farmers, ranches, sisal estates, water bodies and rocky hill tops. Taita Taveta County lies approximately, 380km South East of Nairobi and 140km North West of Mombasa. With population of 340,671 and 96,429 households according to 2019 population censors ("2019 Kenya Population and Housing Census Volume I," 2019) Taita Taveta is considered among the marginalized, Arid and Semi-Arid Counties in Kenya, owing to its climate /rainfall pattern (GoK, 2013). 89% of the county is characterized by semi-arid and arid conditions, with only 2.5% of the county classified as high potential area (Ogallo et al., 2019).

Taita Taveta County experiences two rainy seasons - long rains that come between March to May and short rains between October and December. The rainfall distribution is uneven, with highlands receiving higher rainfall than the lowlands. During the long rains, on average the highlands record 265 mm while the lowlands record 157 mm. Mean rainfall during the short rains is 1,200 mm for highland areas and 341 mm for lowlands, with mean annual rainfall of 650 mm. There is a spatial significant rainfall difference within individual rainfall seasons and this is key in developing climatic resilient policies for the county with short rains season having heavy and higher rainfall than long rains season (Ogallo et al., 2019) The average temperature is 23^{o} C which falls to 18^{o} C in the hilly areas of Vuria, Iyale, Mwambirwa, and Sagalla and rises to about 25^{o} C in the lower zones of Mbololo, Maktau, Voi and Mwatate (GoK, 2013).

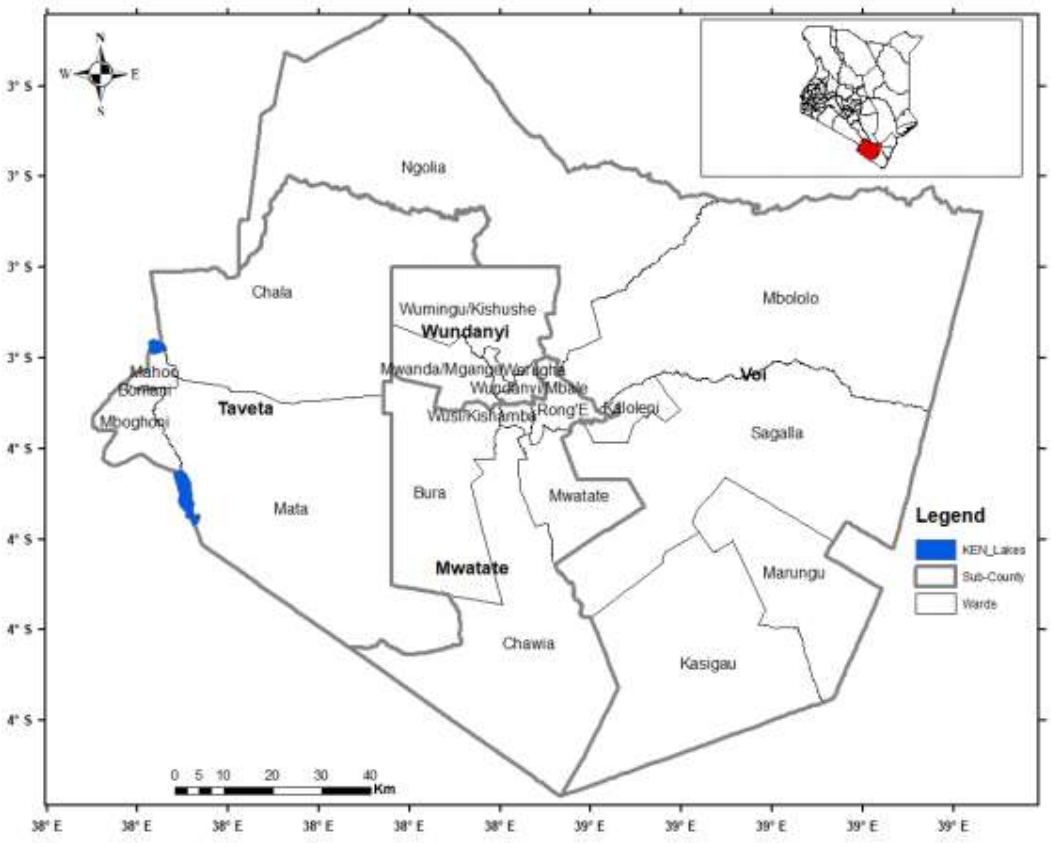


Figure 1. 1: Taita Taveta, Sub-Counties and Wards (Source: Historical Climate Baseline for Taita Taveta- 2019 report

Taita Taveta has been experiencing changes and variability in climate for the last four decades. The long-term environmental changes include soil degradation, reduction of water volume in rivers, landslides, deforestation, drying of wells, boreholes, rivers, perennial droughts, forest fires and persistent invasion of wildlife, causing human-wildlife conflicts. The conflict is as a result of animals leaving Tsavo East and West National Parks in search of scarce water and forage, with some unfortunate incidents leading to death associated with animal attack and destruction of crops and livestock. Acute water shortage in both arid/semi-arid areas and hilly areas is a common phenomenon. In 2013, 2015, 2016 and 2019 torrential rains were experienced that caused flash floods and deaths with hundreds of people being displaced, herds of cattle killed and thousands of acres of crop land destroyed.

Agriculture remains the main source of livelihood in Taita Taveta, contributing about 95% of the household incomes and more than 80% of employment (MoLAF.2016). Absolute poverty stands at 57% while 48% of the population experiences food poverty (MoLAF 2016). The agriculture sector is greatly affected by droughts, floods, unpredictable and unreliable rainfall

and high temperatures brought about by climate change. The effects of climate change are compounded further by low use of inputs, poor infrastructure, high levels of poverty and illiteracy level, with only 40% of households owning title deeds. To increase food productivity, resilience and reduce GHGs, small holder farmers in the region have adapted Climate Smart Agriculture by practicing water harvesting, agroforestry, staggered cropping, soil and water conservation, pasture conservation, changing crop varieties and livestock types and breeds. However, the adaptive capacity of farmers remains low (MoALF: 2016). Therefore, there is need to support adoption strategies such as agricultural crop and livestock insurance, increased irrigation, and mechanization all these falling under Climate Smart Agriculture. These strategic adoption plans can only be successfully implemented if a clear understanding of the psycho-social and social economic factors are researched and established owing to the diverse Agro-ecological/climatic zones found in Taita Taveta County and varied perceptions towards adoption of these new technologies among the local Taitas and Tavetas. Available off-farm services in Taita Taveta that help increase crop and livestock farmers to climate adaptive capacity include extension services and training, fodder conservation, credit, storage, value addition, early-information and production inputs. Of key to note is that several institutions e.g. National & County Governments, Non-Governmental organizations, Community-based organizations and Private Organizations support climate change adaptation efforts in the county through alternative channels such as extension services, delivery of inputs, and policy-making, however the adoption rate still remains very low (MoALF2016). The MoALF 2016, report stated that the local beneficiaries are generally involved in the planning phases of various interventions, but are often absent from subsequent phases including implementation, monitoring and evaluation. It is for this reason the researcher selected Taita Taveta as a study unit to establish the psycho-social, socioeconomic and institutional characteristics influencing the adoption of CSA since its introduction in order to come up with effective adoption strategies that will accelerate the adoption of Climate Smart Agriculture in the region, at the same time provide effective designed policy instrument to remove adoption hurdles as well as crafting tailor made extension services that resonate with the reality of the farmers and hence help foster behavioral change to promote adoption of new sustainable agricultural practices in the region. Also to add to the body of knowledge as little literature/research materials was found covering climate and agriculture related studies in this unique and fragile ecosystem of Taita Taveta.

1.4 Research objective

1.4.1 Main objective:

Assessing psycho-social, socioeconomic and institutional characteristics influencing the Adoption of Climate Smart Agriculture in Taita Taveta County, Kenya.

1.4.2 Specific objective:

i. To evaluate psycho-social characteristics influencing small holder farmer's willingness to adopt Climate Smart Agriculture technologies in Taita Taveta, Kenya.
ii. To evaluate socioeconomic characteristics influencing small holder farmer's ability to adopt Climate Smart Agriculture technologies in Taita Taveta, Kenya.
iii. To evaluate institutional characteristics influencing the adoption of Climate Smart Agriculture technologies by small holder farmers in Taita Taveta.

1.5 Research questions

1.5.1 Main research question:

What are psycho-social, social- economic and Institutional characteristics that influence small holder farmers to adopt Climate Smart Agriculture in Taita Taveta County, Kenya?

1.5.2 Specific research Questions:

i. What are the key psycho-social characteristics influencing small holder farmer's willingness to adoption of Climate Smart Agriculture in Taita Taveta County, Kenya?
ii. What are the key socioeconomic characteristics affecting small holder farmer's ability to adoption of Climate Smart Agriculture in Taita Taveta County, Kenya?
iii. What are key institutional characteristic influencing adoption of Climate Smart Agriculture by small holder farmers in Taita Taveta County, Kenya?

1.6 Significance of the study

The study is important to the people of the County of Taita Taveta, its Government, the National Government, NGOs, small holder farmers and other stakeholders involved in promoting and implementation of CSA, other sustainable agricultural practices and also adds to the body of knowledge on how agriculture and climate can interact in the face of emerging climate change, food insecurity and solving perennial human-wildlife conflict.

1.6.1 Taita Taveta County government

The findings in this study are significant in that the study will identify the psycho-social and socioeconomic factors that are influencing and affecting the adoption rate of Climate Smart Agriculture in the county, hence helping the County Government to come up with effective strategies that will accelerate the adoption as it aims to increase food productivity, resilience, reduce GHGs emission and reduce human wildlife conflicts in the region.

1.6.2 Policy instruments

The findings will provide framework for designing of effective and robust policy instruments to remove adoption barriers as well as craft tailor made extension services that are cognizant with the reality of small holder farmer's behaviour to adoption and will in turn help foster behavioural change and perception in adoption of climate smart agriculture and other sustainable agricultural practices.

1.6.3 Scholars and Researchers

The studies and research on Climate Smart Agriculture is still suffering from limited information and knowledge gaps on the behavioral factors that influence or impede small holder farmer from adopting CSA practices and other new sustainable agribusiness technologies. Research on the various variables in this area will help to unearth hitherto unknown information that will go a long way in facilitating further understanding of the push and pull factors affecting adoption of Climate Smart Agriculture in the global perspective from the human behavioral angle in addition to the social, economic and institutional factors where most empirical studies seem to concentrate. It will also contribute to the existing body of knowledge by providing information related to adoption strategies of CSA among small holder farmers in Taita Taveta and other parts of the world facing similar challenges.

1.7 Limitations and delimitations of the study

Taita Taveta County government officials were reluctant to disclose some of the critical information the researcher needed on the questionnaires due to what they deemed as sensitive and same applied to small holder farmers, especially on matter related to production and income. The sample size of 600 households studied had its inherent limitations beyond the researcher's control. Some respondents were not willing to be interviewed due to the fact that, the interview was conducted during ploughing and planting season. Majority of respondents were busy working on their lands hence according researchers ample time for interviews was a limiting factor which meant a response rate less than 100% response was not forthcoming, the actual response rate was 86.6%. The budget to cover entire Taita Taveta County was high for better research results/findings hence results of the study were limited to two sub-counties mainly Wundanyi and Mwatate. Moreover, the time for conducting the study was not enough since the respondents were spread throughout the two sub counties and households were sparsely distributed. Lastly in strict compliance with Covid-19 protocols effective meetings with respondents were restricted and limited, hence limiting the efficacy of study.

1.8 Assumptions of the Study

The study assumed that the respondents participated fully in the study by giving accurate responses based on the situation on the ground and none was coerced to answer the questionnaire forceful but freely out of their own will and desire to participate in the study. Interviews were conducted after the respondents signed the participation information and consent form.

1.9 Organization of the proposal

The study was structured into chapters. Chapter one introduces the study by looking at the background of CSA and other related studies, justification for the selection of the study units, statement of the problem, objectives of the study and questions, the significance of the study, limitations and delimitations of the study and assumptions made by the researcher in this study. Chapter two tackled the literature review by looking at relevant theoretical and empirical literature's that were related and relevant to the subject in the study. The literature review covered overview of climate smart agriculture, climate change and agriculture globally, in Africa, Kenya and Taita Taveta, County. It also looked at theoretical review, empirical review, research gap, conceptual framework and operationalization of variables. Chapter three covered research methodologies that were used in the collection and analysis of data. Precisely, the sections covered in chapter three were research design, target population, sample and sampling

techniques, data collection, data analysis, and ethical standards. Chapter four on the other hand included presentation of research findings, mainly descriptive data, paired correlations, multivariate probit model and path diagram for psycho-social characteristic. Chapter five captured discussion of result findings and lastly chapter six tackled conclusion and recommendations.

Chapter Two

Literature Review

2.1 Theoretical Review

2.1.1 The Theory of Planned Behaviour TPB (Ajzen's 1991)

The researcher used the Theory of Planned Behaviour TPB (Ajzen, 1991) as the main theoretical framework to analyse farmers' general attitudes towards adoption of Climate Smart Agriculture in Taita Taveta, in order to understand the farmer's behavioral aspect that inform their decision on whether or not to adopt a new technology in this case CSA. The TPB theory argues that a person's intention (INT) is a good predictor of their actual behaviour or actions. Rendering to this theory, a person's attitude (ATT) towards a behaviour, subjective norms (SN) and their perceived behavioral control (PBC) are the key background of person's intention (INT). Person's attitude (ATT) is the extent to which a person has a favourable or unfavourable evaluation of a behaviour and is determined by perceptions of the likelihood of outstanding /significant endings and their evaluation. While subjective norm refers to an individual's perceived social pressure to perform a certain behaviour norm and is determined by normative beliefs and motivation to comply with salient/significant referents. It comprises beliefs about social expectations and the motivation to comply with those expectations. Lastly perceived behavioral control (PBC) is the extent to which an individual feels able to perform the behaviour (Ajzen, 1991) PBC is determined by the perceived presence or absence of requisite resources and opportunities and the perceived power of these factors to facilitate or inhibit performance of the behaviour. Actual control influences the impact of PBC on intention and person's behaviour to adopt to a new technology. This component addresses the issue of incomplete volitional control over individual actions (Armitage & Conner, 2001). The model is held to be a complete theory of behaviour in that, any other influences on behaviour are held to have their impact upon behaviour via influencing components of the Theory of Planned Behaviour. However, it is perhaps more correctly regarded as a theory of the proximal determinants of behaviour.

Empirically, the model is specified as follows:

$$INT=\beta 1ATT+\beta 2SN+\beta 3PBC+\varepsilon \qquad (1)$$

Where the βs are empirically estimated weights or path coefficients depicting the relative importance of each of the three variables and ε is the error term. These parameters can be derived from multiple regression in a structural equation model. The relative importance of attitude (ATT), subjective norm (SN) and planned behaviour control (PBC) differs across contexts and type of behaviors under consideration (Ajzen, 1991). Commonly, intention (INT) to adopt CSA is stronger when individuals exhibit positive attitudes, face favourable social environments and have confidence in their ability to perform a given behaviour (Ajzen, 2011). Also, the greater the intention (INT), the more likely one is to perform a behaviour in question (Läpple & Kelley, 2013) in this case the adoption of Climate Smart Agriculture practices.

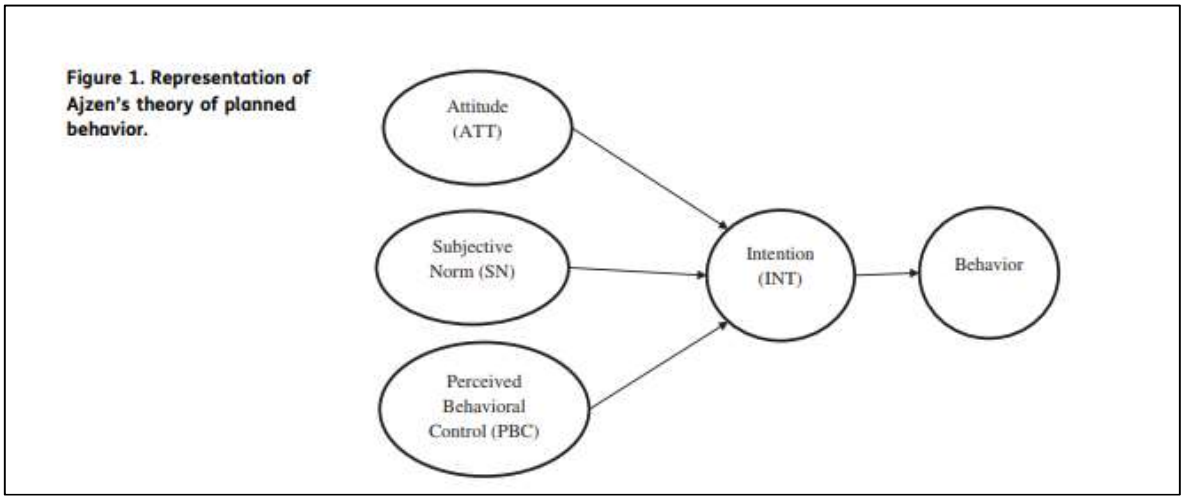


Figure 2. 1: Representation of Ajzen's Theory of Planned Behaviour (Ajzen, 1991)

The key strength of the TPB is its applicability to a variety of behaviors in different contexts (Ajzen, 2011; Meijer et al., 2015). Its overall validity and usefulness has been confirmed by several meta-analytic reviews (Armitage & Conner, 2001; (Godin & Kok, 1996).The research mostly focused on the TPB theories, but also incorporated insights from other behavioral theories such as the Value-Belief-Norm theory (Stern et al., 1999), which focused on how internalized values and moral norms (personal norms) influences individual behaviour; the Technology Acceptance Model (Davis & Davis, 1989), and Unified theory of Acceptance and Use of Technology which explains an individual's technology acceptance as a function of perceived usefulness and perceived ease of use.

2.1.2 The theory of Technology Acceptance Model (TAM) (Davis 1989)

In 1989, Davis used Technology Acceptance Model (TAM) to explain computer usage behaviour (figure 2.2). The goal of TAM is to explain the general determinants of computer acceptance that lead to explaining users' behaviour across a broad range of end-user computing technologies and user populations. The same can be applicable or said to acceptance of new technologies like CSA by the users (farmers), the basic TAM included and tested two specific beliefs: Perceived Usefulness (PU) of technology and Perceived Ease of Use (PEU) of technology (Davis & Davis, 1989). Perceived Usefulness is defined as the potential user's subjective likelihood that the use of a certain system (e.g. the use of CSA technology such as irrigation) will improve his/her farm productivity. If the perceived usefulness is greater than the traditional (subsistence farming) technology, then the farmer's attitude towards adoption of such new technology is relative high. However, if the perceived usefulness is low then adoption rate will be low. Perceived Ease of Use (PEU) refers to the degree to which the potential user (the farmer) expects the target system to be effortless (Venkatesh & Davis, 2000). Complicated system or highly technical technologies are difficult to adopt and implement, hence add to barrier in adoption of any technology and tend to slow farmer's adoption and implementation rate. The belief of a person towards a system may also be influenced by other factors referred to as external variables in TAM such as facilitation, which may include off farm activities and institutional/facilitation support systems. The research utilized this theory while assessing the psycho-social, social economic and institutional characteristics that influence the adoption of Climate Smart Agriculture in Taita Taveta in combination with TPB as the main theoretical framework.

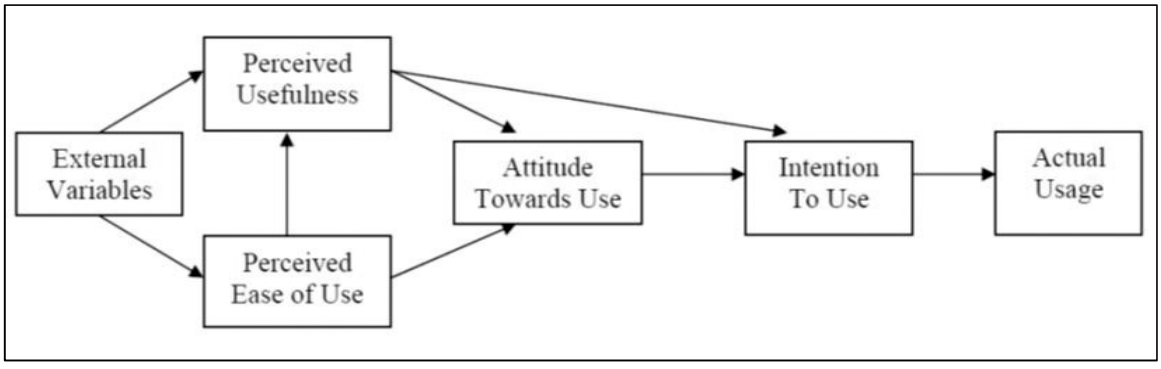


Figure 2. 2: TAM model for adoption of technology (Davis 1989)

2.2 Empirical review

2.2.1 Socioeconomic Characteristics Influencing Adoption of Climate Smart Agriculture

A number of empirical studies have been conducted, mainly focusing on the social-economical angle to adoption of Climate Smart Agriculture and very little has been done on the psycho-social factors, which mainly relate to the farmer's intention/behaviour to making decision on adoption of sustainable agriculture practices. (Branca & Perelli, 2020) notes that while farmers have been playing key role in the process of adoption and up scaling of CSA, the adoption and diffusion of climate-smart technologies has been slow. His study, using a cross-sectional econometric analysis primary data on sustainable farming practices in the cereal-legume farming systems of Ethiopia, Malawi, South Africa and Tanzania, applied to analyse the drivers and intensity of innovation adoption, concluded that socioeconomic barriers were noted to reduce adoption intensity among marginalized farmers and proper incentives were needed to overcome these barriers. He further noted that business links between technology-ready smallholders and small-to-medium enterprises must be created to enable the uptake and scaling-up of innovations and the development of industrial application models. The results further showed that adoption intensity of innovation technology packages is higher, in semi-arid agro-ecological zones and in climates where water is scarce, where there is a perception of increasingly frequent extreme events and erratic rainfall patterns due to climate change; and in mixed crop-livestock systems, however his study omitted the farmer's intrinsic behaviour to adoption of CSA. Simultaneous implementation of CSA practices can sustainably improve farm productivity and can be a strategy for adapting to multiple risks and potential weather shocks. However, CSA fails to achieve its full potential due to low levels of adoption among smallholders and small- medium enterprises (SME's) who have difficulties in scaling up innovations. (Neufeldt et al., 2013) proposed seven key points to overcome hindrances that impede the successful adoption of CSA practices by the poor; these include: provision of an enabling legal and political environment, better access to markets, improved access to decision making process, improved access to knowledge and training, improved tenure rights, overcoming the barriers of high opportunity costs to land, and improved access to capital.

While Brance and Perelli 2020 found out the adoption intensity of innovation is higher in semi-arid Agro-Ecological zones and in climate where water availability may be limiting (Branca & Perelli, 2020) the same is contrary in Taita Taveta, where 89% of parts of the county is arid and semi-arid land and with perennial water shortage (Ogallo et al., 2019) , yet adoption rate is low and lagging behind. It is this contrast/gaps that informed the researcher to study using

a TPB framework in order to get deeper insight and possible underlying human behavioral factors influencing and affecting adoption of CSA in this region.

2.2.2. Psycho-Social Characteristics Influencing Adoption of Climate Smart Agriculture

Empirical literature reviews on barriers to farmers' adaptation of CSA indicated that lack of credit facilities (Maddison, 2007), lack of information on adaptation options (Deressa et al., 2011); Chukwuone, & Agu, 2011), lack of access to water, labour shortages (Deressa et al., 2008;(Sofoluwe et al., n.d.) and irregularities of extension services (Gbetibouo, 2009) constitute the major factors that challenge adoption of practices. These barriers point out to the researchers' bias towards social- economic factors leaving psycho-social factors under researched.

McCarthy et al. (2011) showed that up-front investment costs, opportunity and transactions costs across a wide range of investments and practices can be significant barriers to adoption of CSA practices. Moreover, according to the authors, potential synergies between the three main pillars of CSA (food security, adaptation and mitigation opportunities), as well as costs, can differ substantially across different Agro-Ecological zones, climate regimes, and historical land use patterns. Barnard et al. (2015), argues that factors hindering adoption of CSA practices can be classified under two broad categories: hardware barriers (including physical inputs such as land; human resources; equipment; infrastructure and finances) and non-physical or software barriers (institutional, cultural, policy and regulatory environment; information, knowledge and skills; technologies and innovations; and governance).The researcher in his broad categories also overlooked the psycho-social dynamics like attitude or intention of the farmer towards CSA adoption.

Also according to (Stevenson et al., 2014), the main barriers to CSA technologies, adoption were lack of sufficient financial capital, difficult access to or low availability of the necessary agricultural inputs (tools, seeds and fertilizers) and in some cases insufficient labour to carry out the practice. Water scarcity was also a major hurdle for practices such as micro-irrigation, dry season gardening and agroforestry (farmers reported that tree seedlings often died due to lack of water).

(Descheemaeker et al., 2016) also argues that major institutional barriers (such as access to markets and relevant knowledge, land tenure, insecurity and the common property status) limit the adoption potential. However, few researchers have attempted to study the farmer's

behaviour in decision making by looking at farmer's attitude subjective norms and perceived behaviour control.

While applying the theory of planned behaviour (TPB) as well as ordered probit model and partial least square structural equation modelling in Ethiopia highland (Mutyasira et al., 2018) found that social economic factors such as access to agriculture loans, off-farm income, availability of household labour and livestock ownership increase the probability of a farmer adopting two or more sustainable agriculture practice. The results showed that farmer's intention and personal norms significantly influenced the number of sustainable agricultural practices a farmer adopted at farm level. While assessing the impact of social-psychological factors on actual adoption of sustainable land management practices (Zeweld et al., 2018) also found that farmers attitudes, information, education, group membership, relational capital, risk attitudes and labour supply significantly affected the probability of adopting land agricultural practices. Estimates of the ordered probit model also indicate that extension services, risk attitudes, group membership, social capital, education and labour supply were major determinants of the number of land management practices used. However, financial resources, biophysical factors and some demographic factors were found to have an insignificant effect on sustainable agriculture adoption. This inspire the researcher to look in depth at psycho-social factors influencing adoption, with an aim of aligning and informing the findings to the key stakeholders in coming up with better strategies, that include farmers intrinsic related behaviour to sparing adoption of CSA. These theoretical and empirical reviews also informed the bases for researcher identification of the various psycho-social and socioeconomic independent variables to consider in developing the conceptual frame work and in conducting this research.

2.2.3 Institutional Characteristic Influencing Adoption of Climate Smart Agriculture

A growing body of literature suggest that technology oriented interventions alone may not be enough to achieving sustainable agriculture transformation due to the complexity of institutional contexts within which agriculture operates. Existing literature acknowledges the importance of some institutional factors such as: markets, government support, subsidies, credit from financial institution, research institutions and private partnership engagements in agricultural development, for effective adoption of sustainable agricultural practices (Sunding & Zilberman, 2000) .(Reardon et al., 1998) observed that investment in rural infrastructure

such as roads, can stimulate the reduction of transport cost hence increasing farmer's access to markets leading to substantial agriculture expansion and adoption of new technologies.

Institutional constraints such as credit and land tenure, may affect the pattern of adoption and technology but on the other hand introduction of new technology may affect the institutional structure and the way agriculture operates (Totin et al., 2018). Asymmetric information between lenders and borrowers and uncertainty in agriculture and financial markets have led to imperfection in the credit markets hence affecting adoption behaviour (Samanta et al., 1995). In most cases, farmers need to use their own equity to finance at least part of their investment in other cases, assets such as land or crop/livestock itself may be used as collateral to finance new technology. However, in areas where title deeds are lacking like in Taita Taveta, getting credit could be one of the limiting factors to adoption of CSA. Credit constraints (per acre), interest rates and other charges may also affect adoption rate as banks and other mainstream financial institutions perceive small holder farmers to be riskier, making their credit more expensive and costly. Costly credits, add the hurdle of adoption of new technologies and also reduce the minimal farm size that is required for adoption practice.

While assessing if there are systematic gender difference in the adoption of sustainable agriculture intensification, (Ndiritu et al., 2014) argue that social capital, plot and house hold characteristic influence technology adoption, they noted that trekking distance also affects market access and by extension transportation which are directly associated with transaction cost associated with input–output marketing activities and can negatively influence the small holder adoption of sustainable agriculture intensification through increased travel time and transport cost .

Input subsidies on the other hand lead to adoption of higher yielding varieties, breeds and use of fertilizer, this in turn increases productivity and thus indirect positive impact of adoption. However, despite the input subsidies from the government /county government intervention and availability of extension services and non-governmental support, Taita Taveta still lags behind in adoption of climate smart agriculture. This further cemented the need for the researcher to conduct this research.

2.3 Conceptual Framework

2.3.1 Independent Variables

Independent variable that were assessed include:

Socioeconomic characteristics.

Gender of the house hold, age, marital status, years of education, house hold size, farm income, non-land assets ownership and farmers' group membership.

Institutional characteristics:

Access to credit, confidence in extension service offered, government support, county support, access to inputs subsidies and non-governmental Support.

Psycho-social Characteristics

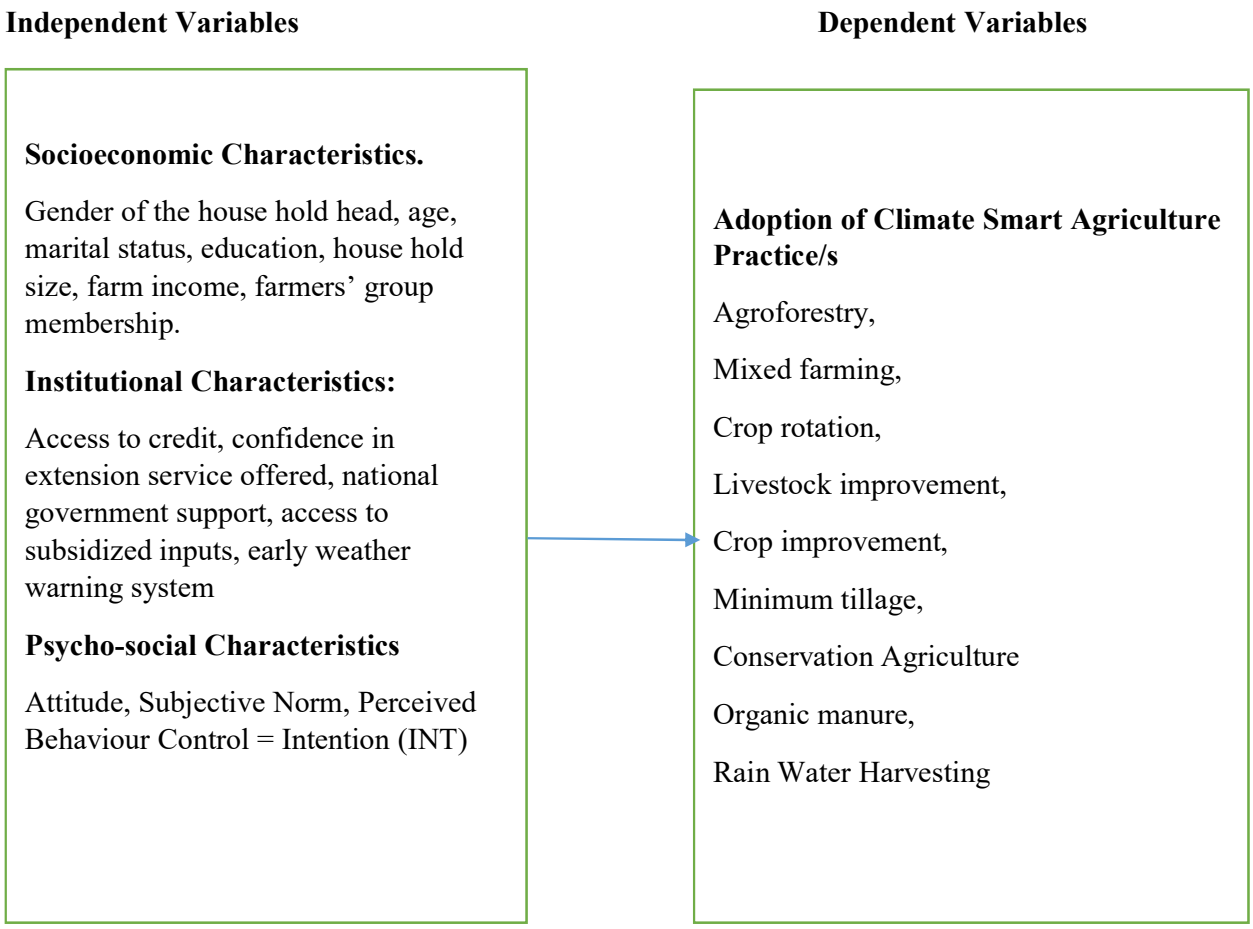
Attitude, Subjective Norm, Perceived Behaviour Control and Intention

2.3.2 Dependent Variable:

Climate Smart Agriculture Practice/Technologies being adopted by small holder farmer in Taita Taveta include:

Agroforestry, Mixed farming, Crop rotation, Livestock improvement, Crop improvement, Minimum tillage, Conservation Agriculture, Organic manure, Irrigation practices and rain water harvesting

2.3.3 Conceptual Framework



2.3.4 Operationalization of Variables

The research had both observed and unobserved variables. Observed variables e.g. education, house hold size, age, house hold size) and latent or unobserved variables (e.g. attitude, social capital, subjective norm, perceived behaviour control),

Table 2. 1: Description of Independent and Dependent Variables

Variables	Description
Social economic characteristics. (Demographics)	

Gender	Dummy =1 if house hold leader is male
Age	Age of the house hold head
Marital status	Dummy =1 if married
Education	Number of years in schooling
House hold size	Number of house hold family members
Off farm income	1 if house hold have off farm income
Non-Land Asset ownership	The approximately value of total non-land asset in KShs
Farmers group membership	1 if the house hold head is in any farmer group membership
Institutional characteristics:	
Access to credit	1 if house hold have access to credit 0 if not
Extension service	1 if house hold have confidence in extension service they get 0 if otherwise
Government support	1 if there is government support /interventions 0 if no government intervention/support
County government support	1 if there is any support from the county government 0 if none.
NGO support	1 if there is any NGOs support 0 if none
Access to subsidized farm input support e.g. Fertilizer /seeds /seedlings	1 if the house hold accessed subsidized farm inputs 0 if none.
Farm characteristics:(CONTROL)	
Farm size in acres	Number of acreage per house hold
Farm income	Average yearly income earned through sell of farm products
Agro ecological location (lowland /highland)	1 if its Arid and Semi-Arid while 0 for highland zone
Trekking distance	Time in minutes taken to walk to the farm

Incidence of human wildlife attack	1 if there are incident of wildlife attack on crops or human 0 if none
Use of inorganic fertilizer	1 if the house hold use inorganic fertilizer 0 if they use organic manure
Irrigation water availability	1 if water is available for irrigation 0 if not available
Early weather warning system	1 if house hold gets access to weather information 0 if no access information
Climate Smart Agriculture Practice Adoption –Dependent Variables	
Agroforestry	1 if the household head adopts agroforestry/tree planting practices 0 if otherwise
Mixed farming	1 if the household adopts mixed farming 0 if otherwise
Crop rotation	1 if the house hold adopts crop rotation 0 if otherwise
Livestock improvement (high yielding livestock breeds)	1 if the house hold keeps improved livestock breeds O if none
Crop improvement (high yielding/disease resistance varieties)	1 if house hold grows high yielding crop varieties 0 if none
Minimum tillage	1 if house hold adopt minimum tillage ,0 if otherwise
Conservation agriculture e.g. terraces furrow /contour farming windbreaks	1 if house hold adopt conservation agriculture practice, 0 if otherwise
Rain water harvesting	1 if household harvests rain water , 0 if otherwise
Organic manure	1 If house hold adopt the use of organic manure and 0 if otherwise

Table 2. 2: Description of Psycho-social variable were analyzed using questions worded by (Ajzen 2002) recommendations.

Construct	ITEM	Description
ATTITUDE (ATT)	ATT1	I think CSA increases my crop yield
	ATT2	I think CSA increases farm income
	ATT3	I think CSA reduce climate change
	ATT4	I think CSA improve my reputation in the community
Subjective Norm (SN)	SN1	Most farmers important to me apply CSA on their farms
	SN2	People important to me would think that using CSA would be good idea
	SN3	Most farmers in my community expect me to use CSA on my farm
	SN4	When it comes to choosing CSA farming practice I want to be like other farmers in my community
Perceived Behavioral Control (PBC)	PBC1	I would be able to practice at least one of CSA
	PBC2	I have resources to implement CSA practice
	PBC3	I have the knowledge to try out or practice CSA
INTENTION (INT)	INT1	I intend to use CSA
	INT2	I will try to adopt at least one of the CSA practice
	INT3	I am planning to adopt CSA practice

Respondents were asked to rate their agreement to the statements on all the measurement items using a Likert scale of 1-5, with 1 being Strongly Disagree, 2-Disagree, 3-Neutral, 4- Agree and 5 strongly Agree.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Research Design and Methodology

A mixed research research methodology was used in the study this included qualitative and quantitative research methods. The research design included the use of structured questionnaire, house hold survey, literature review and participatory methods. Small scale farmers were the point of focus in this research since CSA in Taita Taveta mainly targeted the small holder hold farmers who formed bulk of food /livestock producers in the region. House hold interviews were done in a form of structured questionnaire that captured broad issues that included socioeconomic characteristics, institutional characteristic, farm characteristic and psycho-social characteristic. County officials in the Ministry of Agriculture, environmental officials and key informants like extension officers, administration officers, chiefs, assistant chiefs and social groups leaders were also interviewed.

3.2. Target population/Sampling

3.2.1 Sample size

With population of Taita Taveta standing at 340,671 persons and 96,429 households as per the 2019 population census report ("2019 Kenya Population and Housing Census Volume I," 2019) Sample size for households was determined using equation suggested by Yamane (1967) below;

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

Where: -

n = Sample size

N= Population size

e = 0.05(Precision level) assuming the confidence level is 95% i.e.: ± 5

The calculated household sample size based on above equation was 399.53, rounded off to 400 households, however a sample size of 600 households, was considered, to take care of lack of response from the respondent, poor reporting by enumerators, lack of dates or indication of location by enumerators and other error/inconsistencies that arose during the data collection. Of the 600 targeted samples size and after clean-up of data and data entry, a total of 521 returns

were used for this research out of which 67. % were male and 33% were female, giving a response rate of 86.8% of the total targeted sample size.

3.2.2 Target Population

The population is often referred to as the "universe" in reference to all items in the field of investigation (Kumar, 2008). The study population consisted of small holder farmers purposive selected from two Sub Counties with two different agro-ecological zone (high and low) that had practiced CSA for one season and were still practicing during the time of interview. The appropriateness of the study population was informed by the high number of vulnerable women who form the bulk of labor in household's farms and comprised a total 600 household's respondents practicing CSA. 300 households from high altitude zone of Wundanyi Sub County, which serves as the main water catchment area for the residence of Taita Taveta and its where CSA practices were first introduced in the county, while the other population of 300 households from lower altitude zone of Mwatate Sub- County that borders Tsavo West, its where perennial human wildlife conflicts are frequent and CSA was introduced to reduce these conflicts. Initial 300 house hold per Sub County were be broken down into 150 households, per ward (Wumingu, Mwanda-Mghange, Chawia, Bura-Maktau) followed by 75 households from each Sub Wards (Kishushe, Mwatate, Makutau, Mwanda, Mgange Dawida, Chawia, Bura, Mwachabo). While the researcher targeted 600 house hold, after clean up actual returns were 521 respondents.

3.2.3 Sampling techniques:

The research used a multistage sampling technique in the study, the first stage was the purposive selection of two Sub Counties, that is Wundanyi and Mwatate, owing to the fact that CSA was introduced into these two Sub Counties. Wundanyi with highland agro ecological climate and serve as the main water tower for the County, while Mwatate bordering the Tsavo West Nation park, and lying on the lower land with Arid and semi-arid agro ecological zone and has been experiencing many incidences of human wildlife conflicts. The second stage was purposive selection of two administrative wards each within the selected two Sub Counties that have households practicing CSA, followed by the third stage which was purposive selection of two sub wards within the administrative ward and finally we randomly selected 75 households per sub ward (8 sub wards) making our sample target size of 600 households, however after clean up the result of 521 respondents were used for this research and data analysis.

3.3 Data Collection Methods, Tools and Analysis

For the purpose of this study, it was assumed that a farmer is considered to adopt CSA if he or she has practiced the activity for one season and was still practicing CSA during the time of interview (Afolami et al., 2015).The research also assumed that each household head compares the CSA with the traditional practice and adoption was based on perception that the CSA practice utility was greater than the traditional practice (Awotide et al., 2016). The study also assumed a household head needs to make multiple adoption decision at the same time. Attempting to model adoption of single practice separately using Probit or Logit model ignored the potential correlations among the unobserved disturbances in adoption equations, thus leading to insufficient estimate and thereby wrong interpretation (Theriault et al., 2017). The study therefore utilized Multivariate Probit model (MVP), which simultaneously models the influence of the set of explanatory variables on each of the different CSA practice by estimating a set of binary Probit model simultaneously while allowing the error term in those models to be correlated (Green 2008). From our data analysis a positive and significant likelihood ratio of ρ_{ki} implied rejection of null hypothesis of the error term correlation, thus justifying the use of multivariate probit model.

3.3.1 Multivariate Probit Model

The observed outcome of CSA adoption was modeled following a random utility formulation, by considering the ***ith*** house hold **(i=1……N)** facing the decision to either adopt or not to adopt CSA practice on his farm **(p**). Letting U_0 represent the benefit to the farmer from traditional management practice and letting the **U*k*** represent the benefit of adopting the ***kth*** CSA. Where ***k*** denotes choice of Climate Smart Agriculture practice, the farmer decides to adopt the ***kth*** CSA practice on the farm ***p*** if:

$$Y^*_{ipk} = U^*_k - U_0 > 0.$$

However, the net benefit ***(Y*ipk)*** that the farmer derives from adoption of the ***kth*** CSA practices: (A=Agroforestry, M=Mixed farming, C=Crop rotation, L=livestock improvement (high yielding crops/livestock-varieties/breeds), T=Minimum tillage, G=Conservation Agriculture, I=Irrigation, O-Organic manure, F=Farmer insurance) were latent variables determined by observed personal, household, farm and location characteristic ***(Xi)*** and the error term ***(Ɛi).***

$$Yipk = Xi\beta + Ɛi \qquad (k=A, M, C, L, T, G, I, O, F) \qquad (1)$$

The unobserved preference in the equation (1) above translated into observed binary outcome equation for each choice as follows

$$Y_{ipk} = \begin{cases} 1 \text{ if } Y^{*}_{ipk} > 0 \\ 0 \text{ otherwise} \end{cases} \qquad \textit{(k=A, M, C, L, T, G, I, O, F)} \qquad \textit{(2)}$$

When analyzing the determinate of adoption the researcher took into consideration, the influence of non-observable house hold characteristics on adoption decisions, farm invariant and variant characteristic. This included management ability, average distance to the farm, and average farm characteristic as additional covariant in the regression model.

3.3.2 Analyzing the psycho social data

In utilizing theory of TPB in assessing the psycho-social factor that influence adoption of Climate Smart Agriculture, attitude was measured directly by considering four questions asked to the farmer on the degree to which they agreed with the notion that using CSA increased farm yields, incomes, reduce climate change and the farmer's reputation in community (ATT1, ATT2, ATT3 and ATT4). While subjective norm was captured by considering the opinions of important people and fellow farmers in the community in relation to adoption of CSA. Perceived behaviour control, was also measured by considering the extent to which farmers were confident in their ability to implement CSA on their farms. Finally, intention (INT) was captured by a person's or household's readiness to adopt CSA in terms of availability of resources or educational experiences. These questions were worded following (Ajzen, 2002) recommendation. In total, 14 questions directly based on this theory were used to create indices of each of the four constructs. Farmers' responses to these questions were measured on a 5-point Likert scale ranging from 1 = strongly disagree, 2 =disagree,3=neutral, 4=agree to 5 = strongly agree, indicating the degree to which they agreed with the set of statements as provided for in the structured questionnaire.

3.4 Data Analysis

Collected data was cleaned and analyzed. The data entry was done using Statistical package for social scientists, SPSS.25 while data analysis was done using Stata 14 software. A Structural equation modeling analysis (SEM) was adopted to come up with path diagram for psycho-social characteristics in adoption of CSA practices for analyzing objective one of the study while multivariate probit model was used to analyze objective two and three.

3.5 Research Quality

To ensure validity and reliability, all the research assistants were trained on how to conduct interviews, where, when and what time the interviews were to be conducted e.g. refrain participants from filling questionnaire during lunch hour. The research used the same research assistants including the author to conduct the research in the two selected Sub Counties. The author wrote memos to promote suitability as well as code the data, analyse and interpreted the data. Selection of two counties also promote external validity within the context of the two different agro ecological zones that were selected during research.

3.6 Ethical Considerations

From the choice of research topic which was aimed at increasing food security in the face of climate change and in line with sustainable development goal (SDG) 1, 2 and 13, designing of research, collecting of data, processing and analyzing of data, utmost integrity, objectivity, confidentiality and anonymity was enforced and practiced. Respondents were explained on what the research was all about, allowed to asked questions before the interview and upon satisfactory understanding of the purpose of study, they were free to sign participant's information and consent form before commencement of the interview.

Relevant permits and authorization to conduct the research were applied for these included authorization letter from Strathmore University Ethical review body, permits from University research body (NACOSTI), Ministry of Education-Director County Education, the County Government and County commissioner.

CHAPTER FOUR

PRESENTATION OF RESEARCH FINDINGS

4.1 Introduction

The chapter entails the analysis of the data collected using the methodology proposed in the previous chapter and the discussions of the research findings. The chapter is divided into sections which covers the questionnaire response rate, descriptive statistics, correlation analysis, multivariate probit model analysis and structural equations modelling. The dependent variable of the study is climate smart agriculture practices while the independent variables comprise; socioeconomic, institutional and psychological characteristics.

4.2 Response rate

Questionnaire response rate was 86.83% as shown in table 4.1 below. The response rate is sufficient since it surpasses the average rate of 30% as recommended by Saunders and Lewis (2009).

Table 4. 1: Questionnaire response rate

Respondents	Sample size	Returned	Response rate (%)
Total	600	521	86.83

Source: Researcher 2021

The response rate implies the quality of questionnaire was satisfactory. The questions were designed in a manner that motivated the respondents to complete and give accurate information resulting to the high response rate of 86.83%.

4.3 Influence of socioeconomic and institutional characteristics on small holder farmer's willingness to adopt Climate Smart Agriculture technologies in Taita Taveta, Kenya.

To address the second and third objectives of the study, a multivariate probit model analysis was adopted to estimate the influence of socioeconomic and institutional characteristics on adoption of climate smart agriculture by small holder farmers in Taita Taveta Kenya.

4.3.1 Descriptive Statistics

Table 4.2 presents the descriptive statistics for the explained and explanatory variables. Regarding Climate Smart Agriculture practices in Taita Taveta, the results revealed that 97% of the sampled households had adopted mixed farming while 85% had adopted crop rotation.

Additionally, the findings indicated that agroforestry was embraced by 83%, crop improvement by 81%, use of organic manure by 75% and livestock improvement by 67% of the sampled households. Moreover, an equal proportion of 74% had adopted conservation agriculture and minimum tillage each.

For the socioeconomic characteristics, the findings indicated that 67% were male while the average years of the household head was 45years with standard deviation of 13.096, minimum and maximum of 22 and 89 years respectively. A proportion of 82% of sampled household heads were married and average household size was 5 people with minim been one person and maximum 20 people. Moreover, the average years in schooling of the household head was 9.91 with standard deviation of 3.66, a minimum of zero and a maximum of 20 years. Further, 53% of sampled household heads were members of farmer groups.

Concerning the institutional characteristics, 73% of the sampled households head had access to credit facilities while 79% had confidence in extension services offered to Taita Taveta residents. Furthermore, 49% affirmed that they got national government support while 61% of the households had accessed subsidized farm inputs.

Paying attention to farm characteristics, the average farm size 3.01 acres with standard deviation of 3.0705, minimum of 0.13 and maximum of 50 acres. Nevertheless, the average yearly income earned through sell of farm products for households in Taita Taveta was KShs. 70,275.35 with a minimum of KShs. 2,000 and maximum of KShs. 2,000,000. A proportion of 36% reported that water was available for irrigation, 84% got access to weather information and 83% had experienced incidents of wildlife attack on crops or human.

Finally, for the psycho-social characteristics, the sampled households agreed with constructs for attitude, subjective norms, perceived behavioral control and intention to adopt CSA with means of 4.19, 3.70, 3.61 and 4.30 and standard deviations of 0.620, 0.672, 0.696 and 0.589 respectively.

Table 4. 2: Descriptive Statistics

Variable Name	Description of Variable	N	Mean	Standard Deviation	Minimum	Maximum
Climate Smart Agriculture Variables						

MixedFnmg	The household head adopts mixed farming dummy=1 if yes zero otherwise	521	0.97		0	1
CropRotn	The household head adopts crop rotation dummy=1 if yes zero otherwise	521	0.85		0	1
AgroFtry	The household head adopts agroforestry dummy=1 if yes zero otherwise	521	0.83		0	1
CropImpnt	The household head adopts crop improvement dummy=1 if yes zero otherwise	521	0.81		0	1
OrganMnre	The household head adopts the use organic manure dummy=1 if yes zero otherwise	521	0.75		0	1
ConsrvAgri	The household head adopts conservation agriculture practices dummy=1 if yes zero otherwise	521	0.74		0	1
MinTillge	The household head adopts minimum tillage dummy=1 if yes zero otherwise	521	0.74		0	1
RainWHarV	The household head adopts rainwater harvesting dummy=1 if yes zero otherwise	521	0.69		0	1
LvstckImpnt	The household head adopts livestock improvement dummy=1 if yes zero otherwise	521	0.67		0	1
Socio-Economic Characteristics Variables						
Gender	Gender of household head dummy=1 if male zero otherwise	521	0.67		0	1
Age	The number of years of Household Head	496	45.82	13.096	22	89
MaritStat	Marital Status of household head dummy=1 if married zero otherwise	521	0.82		0	1

Education	The number of years in schooling of the household head	518	9.91	3.66	0	20
HHSize	The number of household family members	520	5.18	2.257	1	20
FGroupMM	The household head is a member of any farmer group dummy=1 if yes zero otherwise	521	0.53			
Institutional Characteristics Variables						
CreditAcc	The household head has credit access dummy=1 if yes zero otherwise	521	0.73		0	1
ExtensionServ	The household head has confidence in extension services offered dummy=1 if yes zero otherwise	521	0.79		0	1
NatGovtSprt	There is National Government Support dummy=1 if yes zero otherwise	521	0.49		0	1
SubsdInputs	Household has accessed subsidized farm inputs dummy=1 if yes zero otherwise	521	0.61		0	1
Farm Characteristics Variables						
FarmSize	The number of acreages per household	511	3.01	3.705	0.13	50
FarmIncome	Average yearly income earned through sell of farm products	443	7027 5.35	125941.20	2000	2000000
IrrigWaterAV	Availability of water for irrigation dummy=1 if yes zero otherwise	521	0.36		0	1
WeatherInfo	Household gets access to weather information dummy=1 if yes zero otherwise	521	0.84		0	1
HWildlife	Incident of wildlife attack on crops or human dummy=1 if yes zero otherwise	521	0.83			
Psycho-social Characteristics Variables						

Attitude	Average constructs score for attitude	517	4.19	0.620	2	5
Subjective_Norm	Average constructs score for Subjective Norms	519	3.70	0.672	1.75	5
PercBehCtrl	Average constructs score perceived behavioural control	519	3.61	0.696	1	5
Intention	Average constructs score for intention to adopt CSA	511	4.30	0.589	2	5

This table presents descriptive statistics. The sample includes 521 households in Wundunyi and Mwatate sub counties of Taita Taveta.

4.3.2 Correlation Analysis

Table 4.3 presents the pairwise correlation between climate smart agriculture proxied by mixed farming and socioeconomic and institutional characteristics. Climate smart agriculture is positively, weakly, and significantly correlated with socioeconomic characteristics- education, membership of farmers group is positively, strongly, and significantly correlated with institutional characteristics- credit access and confidence in extensions services offered. However, it is negatively, weakly, and significantly associated with farm characteristics- farm size.

Table 4. 3: Pairwise Correlations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. MixedFnmg	1															
2. Gender	0.02	1														
3. lnAge	-0.04	0.07	1													
4. MaritStat	-0.05	0.18***	0.17***	1												
5. lnEducation	0.13***	0.06	-0.33***	-0.05	1											
6. lnHHSize	0.02	0.06	0.18***	0.24***	0.04	1										
7. FGroupMM	0.12***	-0.10**	-0.11***	0.11**	0.10**	0.17***	1									
8. CreditAcc	0.09**	-0.13***	-0.16***	-0.03	0.12***	0.12***	0.40***	1								
9. ExtensionServ	0.07*	-0.12***	-0.10**	0.03	0.09**	0.07	0.35***	0.20***	1							
10. NatGovtSprt	-0.05	-0.05	-0.14***	0.01	0.11**	0.05	0.26***	0.02	0.25***	1						
11. SubsdInputs	0.02	-0.09**	-0.13***	0.07	0.03	0.09**	0.37***	0.18***	0.37***	0.57***	1					
12. lnFarmSize	-0.11***	0.12***	0.11**	0.13***	0.03	0.21***	0.15***	0.004	0.08*	0.19***	0.33***	1				

13.lnFarmIncome	0.20***	0.08	0.03	0.05	0.24***	0.13***	0.03	-0.12***	0.11**	0.05	-0.11**	0.13***	1			
14. IrrigWaterAV	0.06	0.05	0.12***	-0.07	-0.01	-0.04	-0.19***	-0.14***	0.07	-0.43***	-0.47***	-0.34***	0.18***	1		
15. WeatherInfo	0.01	-0.10**	-0.05	0.08*	-0.05	0.05	0.10**	0.01	0.11***	0.33***	0.38***	0.19***	-0.19***	-0.32***	1	
16. HWildlife	0.07	0.13***	0.08*	0.12***	-0.02	0.04	0.01	-0.05	0.04	-0.15***	-0.02	0.21***	0.06	0.04	-0.04	1

This table presents pairwise correlations among dependent and independent variables. The sample includes 521 households in Wundunyi and Mwatate sub counties of Taita Taveta. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively.

4.3.3 Multivariate Probit Model Analysis

From table 4.4 below, a positive and significant likelihood ratio of ρ_{ki} implied rejection of null hypothesis of the error term correlation, justifying the use of multivariate probit model. Additionally, a significant Wald test χ^2 test enabled us to reject the conjoint nullity of variable coefficients included in the estimation.

Our null hypothesis was that no significant difference between the socioeconomic, institutional characteristics and adoption of climate smart agriculture practices in Taita Taveta. This implies that irrespective of household's socioeconomic and instructional characteristics, the house hold will adopt a given practice of climate smart agriculture.

The findings predict that gender, marital status, education, membership of farmers' group, confidence in extension services offered, national government support, farm income and availability of water for irrigation significantly influence household's choice of mixed farming practice of climate smart agriculture. The coefficients of education, membership of farmers' group, farm income and availability of water for irrigation are positive and significant this is consistent with Peterson (2014) who argues that the main barriers to adoption of climate smart agriculture is water scarcity for micro irrigation, lack of sufficient financial capital, difficult access to or low availability of the necessary agricultural inputs (tools, seeds and fertilizers), and in some cases insufficient labour to carry out the practice . Therefore, household's heads with more years in schooling, having membership of farmers' group, high farm income and available water for irrigation are more likely to adopt mixed farming practice. The coefficients of gender, marital status, confidence in extension services offered and national government support are negative and significant. Thus, being male, married, having confidence in extension services offered and receiving national government support suggests a higher likelihood of not adopting mixed farming.

Additionally, the results posit that marital status, membership of farmers' group, credit access, confidence in extension services offered and national government support affect the households' choice of crop rotation practice. The coefficients of marital status, membership of farmers' group, credit access and confidence in extension services offered are positive and significant. Therefore, household's heads who are married, have membership of a farmers' group, have access to credit and have confidence in extension services offered are more likely to adopt crop rotation practice this also concurs with Neufeldt et al. (2011) findings, who noted that improve access to knowledge and training through group membership, access to capital spur adoption of sustainable agriculture practices. However, the coefficient for national government support is negative and significant implying a higher likelihood of not adopting crop rotation.

Moreover, the findings postulate that gender, marital status, membership of farmers' group, credit access, confidence in extension services offered, farm size, farm income and availability of water for irrigation influence the households 'choice of agroforestry practice. The coefficients of gender, membership of farmers' group, credit access, confidence in extension services offered, farm size and availability of water for irrigation are positive and significant. This implies that household's heads are more likely to adopt agroforestry practice if are male, members of a farmers' group, access credit, confident of the extension services offered, having larger farm size and water is available for irrigation. However, the coefficients of marital status and farm income are negative and significant. Therefore, being married and having high income predicts a higher likelihood of not adopting agroforestry practice.

Further, the results envisage that membership of farmers' group, confidence in extension services offered, subsidized farm inputs, availability of water for irrigation, weather information and wildlife attack affect choice of crop improvement practice. The coefficients of membership of farmers' group, confidence in extension services offered, weather information

and wildlife attack are positive and significant. Thus, household's heads with membership of a farmers' group, confident in extension services offered, access weather information and experience incidences of wildlife attack are more likely to adopt crop improvement practice. The coefficients of subsidized farm inputs, availability of water for irrigation are negative and significant, thus receiving subsidized farm inputs and available water for irrigation suggests a higher likelihood of not adopting crop improvement practice.

Nevertheless, findings predict that marital status, membership of farmers' group, credit access, confidence in extension services offered, subsidized farm inputs, farm income, availability of water for irrigation, weather information and wildlife attack influence the choice of using organic manure practice. The coefficients of marital status, membership of farmers' group, credit access, confidence in extension services offered, subsidized farm inputs, availability of water for irrigation and weather information are positive and significant. Therefore, married household's heads with membership of farmers' group, access to credit, confident in extension services offered, receive subsidized farm inputs, available water for irrigation and access to weather information are more likely to use organic manure practice. The coefficients of farm income and wildlife attack are negative and significant. Thus, having high farm income and experiencing wildlife attack yields to higher likelihood of not using organic manure practice.

Furthermore, the results suggest that education, household size, membership of farmers' group, credit access, confidence in extension services offered, national government support, subsidized farm inputs, farm income, availability of water for irrigation, weather information and wildlife attack influence the households' choice of conservation agriculture practice. The coefficients of education, household size, membership of farmers' group, credit access, confidence in extension services offered, subsidized farm inputs, availability of water for irrigation, weather information are positive and significant. Households heads with more years in schooling, high household size, member of farmers' group, access to credit, confident in

extension services offered, access to subsidized farm inputs, available water for irrigation and access to weather information are more likely to adopt conservation agriculture. However, the coefficients of national government support, farm income and wildlife attack are negative and significant. Therefore, receiving national government support, high farm income and experiencing wildlife attack leads to higher likelihood of not using conservation agriculture this confirms the ministry of agriculture livestock and fisheries report that noted that several institutional organization e.g. government, county government, non-governmental, community-based and private organizations support climate change adaptation efforts in the county through alternative channels such as delivery of inputs, and policy-making, however the adoption rate still remained very low (MoALF2016).

Besides, the findings suggest that membership of farmers' group, credit access, weather information and wildlife attack affect the households' choice of minimum tillage practices. The coefficients of membership of farmers' group, credit access and weather information are positive and significant but of wildlife attack is negative and significant. Therefore, households head with membership of farmers' group, access to credit and weather information are more likely to adopt minimum tillage practice while experiencing wildlife attack suggests a higher likelihood of not adopting minimum tillage.

Consequently, the results predicts that credit access, confidence in extension services offered, national government support, farm size, farm income and availability of water for irrigation influence households' choice of rainwater harvesting practice, this is consistence with (Sunding & Zilberman, 2000) who acknowledges the importance of some institutional factors such as: government support, subsidies, credit from financial institution, research institutions and private partnership engagements in agricultural development act as catalyst for an effective adoption of sustainable agricultural practices The coefficients of credit access, confidence in extension services offered, national government support and farm size are positive and

significant but of farm income and availability of water for irrigation are negative and significant. Households heads with access to credit, confident in extension services offered, receiving national government support and large farm size are more likely to adopt rainwater harvesting. However, having a high farm income and available water for irrigation predicts a higher likelihood of not adopting rainwater harvesting. This findings are consistent with (Branca & Perelli, 2020) findings that showed adoption intensity of innovation technology packages is higher, in semi-arid agro-ecological zones and in climates where water is scarce, where there is a perception of increasingly frequent extreme events and erratic rainfall patterns due to climate change

Finally, the findings propose that credit access, confidence in extension services offered and farm size affect the households' choice of livestock improvement practice. The coefficients of credit access, confidence in extension services offered and farm size are positive and significant. Thus, household's heads with access to credit, confident in extension services offered and large firm size are more likely to adopt livestock improvement. This result are consistent with (Mutyasira et al., 2018) who found that social economic factors such as access to agriculture loans, and off-farm income and livestock ownership increase the probability of a farmer adopting two or more sustainable agriculture practice

Table 4. 4: Multivariate Probit Model

	MixedFnmg	CropRotn	AgroFtry	CropImpnt	OrganMnre	ConsrvAgri	MinTillge	RainWHarV	LvstckImpnt
Gender	-0.63**	-0.12	0.35**	0.11	0.18	-0.12	-0.22	0.10	0.21
	(0.298)	(0.229)	(0.181)	(0.208)	(0.178)	(0.194)	(0.188)	(0.171)	(0.158)
lnAge	-0.09	-0.45	0.11	-0.34	0.29	0.07	0.09	0.22	-0.05
	(0.579)	(0.353)	(0.323)	(0.335)	(0.334)	(0.354)	(0.306)	(0.302)	(0.295)
MaritStat	-4.21***	0.40*	-0.64***	0.05	0.34*	0.25	0.23	-0.33	-0.14
	(0.783)	(0.229)	(0.257)	(0.265)	(0.201)	(0.207)	(0.204)	(0.206)	(0.188)
lnEducation	0.63*	0.19	0.18	0.16	0.24	0.40*	0.27	0.27	-0.04
	(0.374)	(0.262)	(0.218)	(0.206)	(0.259)	(0.227)	(0.223)	(0.197)	(0.184)
lnHHSize	-0.50	0.21	0.17	0.12	-0.02	0.40**	-0.04	0.08	0.03
	(0.394)	(0.210)	(0.198)	(0.216)	(0.184)	(0.200)	(0.188)	(0.189)	(0.172)
FGroupMM	1.05***	0.53***	0.33*	0.61***	0.42**	0.38***	1.02***	0.26	0.12
	(0.415)	(0.218)	(0.191)	(0.206)	(0.176)	(0.182)	(0.180)	(0.168)	(0.165)
CreditAcc	0.13	1.05***	0.49**	0.23	0.81***	1.02***	0.76***	0.52***	0.50***
	(0.592)	(0.232)	(0.215)	(0.219)	(0.207)	(0.209)	(0.221)	(0.193)	(0.198)
ExtensionServ	-0.89*	0.71***	0.77***	0.65***	0.89***	1.17***	-0.09	0.54**	0.75***
	(0.553)	(0.270)	(0.261)	(0.249)	(0.254)	(0.229)	(0.227)	(0.243)	(0.241)
NatGovtSprt	-1.23*	-1.28***	0.16	0.27	-0.15	-0.39*	0.04	0.36*	-0.05
	(0.699)	(0.341)	(0.233)	(0.250)	(0.216)	(0.213)	(0.226)	(0.194)	(0.198)
SubsdInputs	-0.17	0.47	0.04	-0.59**	0.55*	0.67**	-0.36	0.16	0.06
	(0.654)	(0.339)	(0.294)	(0.274)	(0.301)	(0.281)	(0.276)	(0.230)	(0.228)
lnFarmSize	-0.06	-0.10	0.21*	0.05	-0.01	0.04	-0.04	0.31***	0.25**
	(0.272)	(0.144)	(0.120)	(0.133)	(0.110)	(0.135)	(0.119)	(0.111)	(0.109)
lnFarmIncome	0.82***	0.03	-0.15*	0.02	-0.15*	-0.42***	-0.08	-0.25***	-0.08
	(0.301)	(0.108)	(0.085)	(0.093)	(0.081)	(0.089)	(0.088)	(0.087)	(0.079)
IrrigWaterAV	4.96***	0.07	0.53**	-0.46**	1.15***	0.88***	0.31	-0.78***	-0.11
	(0.862)	(0.280)	(0.269)	(0.217)	(0.300)	(0.271)	(0.221)	(0.198)	(0.204)
WeatherInfo	0.74	0.40	-0.34	1.10***	0.37*	0.38*I	0.56**	0.33	0.15
	(0.637)	(0.309)	(0.265)	(0.245)	(0.227)	(0.237)	(0.239)	(0.228)	(0.227)

HWildlife	0.09	-0.22	0.25	0.41*	-0.46*	-0.70***	-0.44*	0.26	0.33
	(0.477)	(0.265)	(0.237)	(0.253)	(0.273)	(0.269)	(0.269)	(0.243)	(0.207)
Constant	-1.52	0.33	0.43	-0.22	-1.66	1.25	-0.14	0.34	0.04
	(3.283)	(1.914)	(1.701)	(1.745)	(1.659)	(1.634)	(1.675)	(1.453)	(1.463)
Log Likelihood value									-1083.8385
Wald test χ^2 (135)									2079.73***
LR test of p_{ki}									273.647***
Number of observations									406

The table presents estimated parameters of socioeconomic and institutional characteristics on adoption of different Climate Smart Agriculture practices in Taita Taveta County. Robust standard errors in parenthesis accounts for heteroscedasticity. *, ** and *** denote significance at the 10%, 5% and 1% levels respectively.

4.3.4 Structural Equation Modeling (SEM)

To address the first objective of the study, a SEM analysis technique was adopted to analyze psycho-social characteristics on adoption of climate smart agriculture practice by small holder farmers in Taita Taveta, Kenya. A SEM technique was adopted. The first stage of the modeling process involves estimation of the partial least square structural equation modeling to examine the relationship between the TPB construct. The TPB construct are latent thus cannot be observed or measured directly, instead a set of measures are derived from the list of equations to act as indicators for underlying latent variables.

The results are presented below.

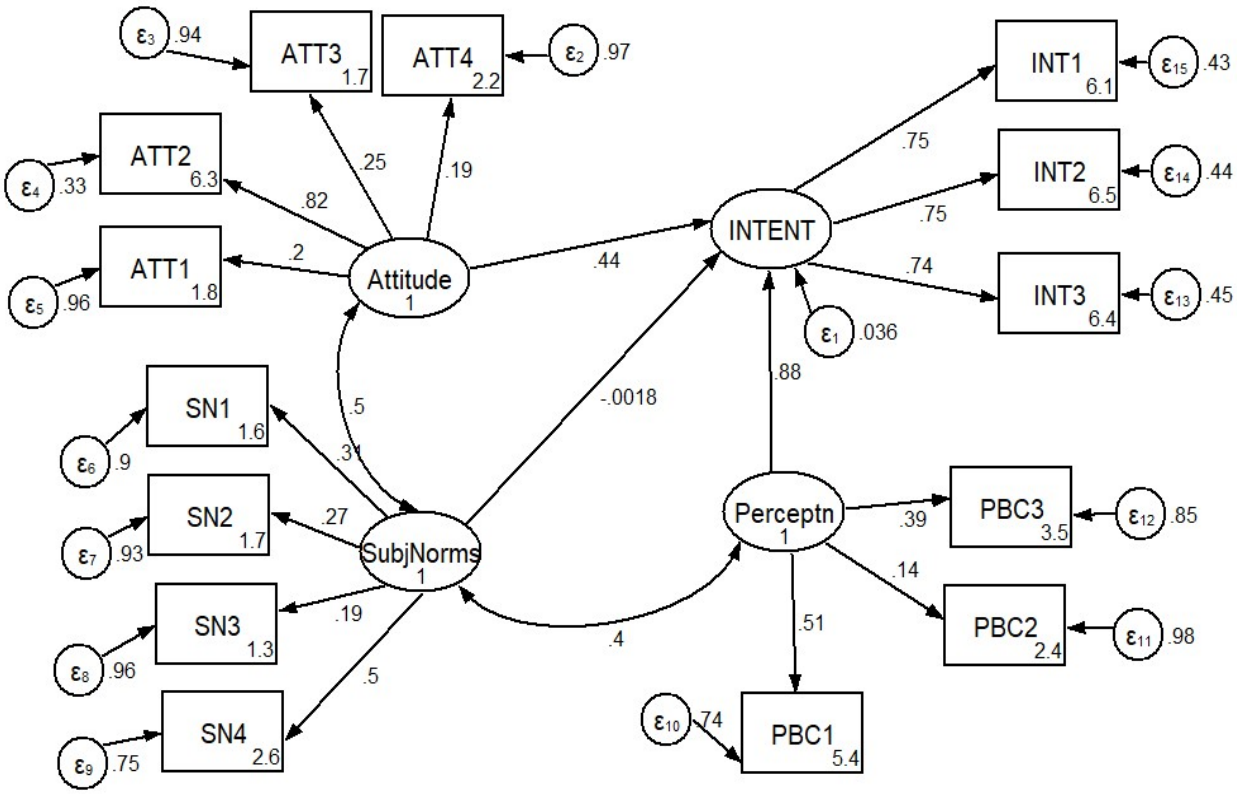


Figure 4. 1: Path Diagram for Psycho-social Characteristics on Adoption of Climate Smart Agriculture Practices

The latent dependent variable was intention (INT) to adopt climate smart agriculture captured using constructs (INT1, INT2 and INT3). The latent independent variables were attitude (ATT) captured using 4 constructs (ATT1, ATT2, ATT3 and ATT4), subjective norm (SN) captured with

4 constructs (SN1, SN2, SN3 and SN4) and perceived behavioral control (PBC) captured with 3 constructs (PBC1, PBC2 and PBC3).

The findings revealed that perceived behavioral control and attitude were positive and significant predictors of intention to adopt climate smart agriculture with path coefficient of 0.88 and 0.44 respectively. This result were consistent with what (Mutyasira et al., 2018) noted that farmer's intention and personal norms significantly influence the number of sustainable agricultural practices a farmer can adopted at farm level . (Zeweld et al., 2018) on the other hand, found that farmer's attitudes, information, education, group membership, relational capital, risk attitudes, and labour supply significantly affect the probability of adopting land agricultural practices, these finding agrees to our findings. Subjective norm was negative and non-significant, it hence does not seem to have direct effect on small holder farmer's intention to adoption of climate smart agriculture agreeing with (Mutyasira et al, 2018) findings.

The constructs for the intention were positive and significant with highest construct being INT1 with path coefficient of 0.75 followed by INT2 and then INT3. Additionally, the constructs for perceived behavioral control were positive and significant with highest being PBC1 with path coefficient of 0.51 followed by PBC3 and then PBC2. Finally, the constructs for attitude were positive and significant with highest being ATT2 with path coefficient of 0.82 followed by ATT3, ATT4 and then ATT1 as depicted in the figure 4.1 above.

CHAPTER FIVE

DISCUSSION, CONCLUSION & RECOMMENDATIONS

5.1 To evaluate how psycho-social characteristics influence small holder farmer's willingness to adopt Climate Smart Agriculture technologies in Taita Taveta, Kenya**.**

Various psycho-social characteristic was evaluated to establish how they influence small holder farmer willingness to adopt Climate Smart Agriculture in Taita Taveta, key among the variables were attitude, subjective norm, perceived behavioral control and intention.

The findings revealed that perceived behavioral control and attitude were positive and significant predictors of intention to adopt climate smart agriculture with path coefficient of 0.88 and 0.44 respectively implying that, perceived behavior control and farmer's attitude a critical psychological characteristic that influence the farmer's intention to adoption of any climate smart agriculture practices in his/her farm. This result were consistent with what (Mutyasira et al., 2018) noted that, farmer's intention and personal norms significantly influence the number of sustainable agricultural practices a farmer can adopted at farm level. (Zeweld et al., 2018) on the other hand, found that farmer's attitudes, information, education, group membership, relational capital, risk attitudes, and labour supply significantly affect the probability of adopting land agricultural practices, these finding agrees to our findings. Subjective norm was negative and non-significant, it hence does not seem to have direct effect on small holder farmer's intention to adoption of climate smart agriculture agreeing with (Mutyasira et al, 2018) findings.

The constructs for the intention were positive and significant with highest construct being INT1 followed by INT2 and then INT3. Additionally, the constructs for perceived behavioral control were positive and significant with highest being PBC1 followed by PBC3 and then PBC2. Finally, the constructs for attitude were positive and significant with highest being ATT2, followed by ATT3, ATT4 and then ATT1 as depicted in the figure 4.1 above. These findings are consistent with the theory of planned behavior (Ajzen, 1991), that argues that person attitude and perceived behavior control are key in adoption of one or two new technologies as further confirmed by the higher percentage of the respondent who had adopted one or two climate smart agriculture practices in Taita Taveta. The results revealed that 97% of the sampled households had adopted mixed farming while 85% had adopted crop rotation, this could be likely because of the intention to increase farm incomes through diversification offered by mixed farming and crop rotations

Additionally, the findings indicated that agroforestry was embraced by 83%, crop improvement by 81%, use of organic manure by 75% and livestock improvement by 67% of the sampled households. Moreover, an equal proportion of 74% had adopted conservation agriculture and minimum tillage each. However, it was established that 36% had adopted irrigation practices while 5% had crop or livestock insurance. The perceived benefits or usefulness of these practices, which may include: increased farm income, diversification of income sources, multiple benefits from mixed farming or agro forestry accrued by these practices and the thought of reducing climate change and improved reputation among their peers could be a booster to adoption of these CSA technologies in Taita Taveta. This further, concurs with the theory of technology acceptance model (Davis & Davis, 1989) which argues that perceived usefulness and perceived ease of use of technology foster adoption of new technology. While adoption is evident, the first pillar of CSA, which is to increase productivity was noted to be very low. Looking at farm characteristics, the average farm size was noted to be 3.01 acres with minimum of 0.13 and maximum of 50 acres. Nevertheless, the average yearly income earned through sell of farm products for households in Taita Taveta was KShs. 70,275.35 with a minimum of KShs. 2,000 and maximum of KShs. 2,000,000 per year. A proportion of 36% reported that water was available for irrigation, 84% got access to weather information and 83% had experienced incidents of wildlife attack on crops or human. With average yearly income of KShs.70, 275.35 from sale of farm produce, scarcity of water and incidence of wildlife attack, crop productivity seem low. Further the result found that mean productivity on crops per year was 0.83 tons for maize, 0.38 tons on beans, 0.83 vegetables and 0.85 for potato growers who were only 48 of the total samples respondents. These productivity result confirm why absolute poverty stands at 57% while 48% of the Taita Taveta population experience food poverty (MoLAF 2016). A call for farmers to consider embracing high yielding/fast growing/drought resistance alternative crops varieties such as potatoes or sorghum as opposed to maize growing need to be promoted, in a region where majority of respondents, 485 grow maize with production of 0.83 tons per year, while of 42 respondents who are growing potatoes had mean production of 0.85 tons per year. However a need to establish why few farmers are growing potatoes or alternative crop varieties need to be established as one key informant stated: *"production of potatoes is better than maize, however challenges of getting certified seeds , outbreak of diseases and market access is our major problem since locals don't consider potatoes as staple food here, they value maize yet its production is low compared to potatoes and worse*

last season we got nothing from growing maize because the rains delayed and were very low". This statement is confirmed by the weather stress and perception results that indicated 86% of the respondent noted rains came late, while 78% experience water scarcity and 87.5% perceived climate has changed affirming (Ogallo et al., 2019) findings.

5.2 To evaluate how socioeconomic characteristics influence small holder farmer's ability to adopt Climate Smart Agriculture technologies in Taita Taveta- Kenya.

Several social economic variables were assessed to establish how they influence smaller holder farmer's ability to adopt climate smart agriculture technologies among them, age, house hold gender, farm income, number of livestock unit, mode of transport to the to market, trekking distance, education level and farmer's group membership. Our result found that there was no significant difference between the socioeconomic, institutional characteristics and adoption of climate smart agriculture practices in Taita Taveta. This implies that irrespective of household's socioeconomic and instructional characteristics, the house hold will adopt a given practice of climate smart agriculture and these result were consistence with what (C. Mungai et al, 2017) revealed that farmers, regardless of gender are willing to adopt Climate Smart Technologies and practices, however factors such as ethnicity, education, age and marital status, determine the level of uptake of climate smart agriculture technologies and practices.The finding predicts that gender, education, marital status, membership of farmers group, access to credit , farm income and availability of water for irrigation significantly influences small holder farmer ability to adopting one or two climate smart agriculture practice like mixed farming ,agroforestry, conservation agriculture among other sustainable practices. On gender, it was also observed that the land was owned by male and had authority on what to do with it, hence influencing what to adopt or not, though the labor is provided by the women marking adoption of certain CSA practices illusive especial those that require male input or participation. Joining a membership of farmers group made it easier for the house hold head to access credit through table banking and this provided platform were the head of the family secure small loans using respective group members as guarantors as opposed to offering collateral in form of land /livestock or expected crop harvested. Furthermore membership of farmers group provided platform to transfer and access of knowledge sharing and support among its members hence making it easy to encourage each other to taking up new technologies hence removing adoption (none physical) software barriers as noted by Barnard

et al. (2015), lack of credit facilities (Acquah, 2011; Maddison, 2007; Nhemachena & Hassan, 2007) and lack of information on adaptation options (Acquah, 2011; Deressa, Hassan, Alemu, Yesuf, & Ringler, 2008; Chukwuone, & Agu, 2011). The result confirms why respondents an able to adopt multiple climate smart agriculture technologies as social and economic barriers were reduced through membership enrollment per technology e.g. potatoes group, dairy group, improved "kienyeji" chicken group. With average age of respondent at 45 years and 9 years of formal education, it was apparent that respondent was able to implement the simple CSA, practices and had strong attitude and perceived behavioral control in terms of ability /know how on trying at least one or two CSA practice.

5.3 To evaluate how institutional characteristics influence the adoption Climate Smart Agriculture by small holder farmers in Taita Taveta.

On evaluation of institutional characteristic influencing the adoption of CSA, various independent variables were analyzed including: access to credit, confidence in extension service offered, support from national government and provision of subsidized farm inputs: the findings envisage that, access to credit, confidence in extension service offered, support from national government had significant influence to adoption of climate smart agriculture. The results confirms (Sunding & Zilberman, 2000) arguments that the importance of some institutional factors such as: markets, government support, subsidies, credit from financial institution, research institutions and private partnership engagements in agricultural development are effective factors to adoption of sustainable agricultural practices. Access to credit eliminate the startup financial barriers associated with initial investment cost for and sustainability of a new technology, this is consistent with (Totin et al., 2018) who argues that Institutional constraints such as credits may affect the pattern of adoption and technology, hence eliminating the barrier of start-up cash constraints through credit access could be the reason why small holder farmers have been able to adopt various practices . Though 73% of the respondent noted to have access to credit of key importance to note during the study is the fear to take loans from mainstream financial institutions and the small amount of cash the respondents take, as alluded to by one key informant who said "*we fear taking loans from major banks, using our land /house /livestock as collateral for fear of losings our assets and due to unpredictable weather that lead to poor harvest and hence increasing risk in borrowing loans. These leads to taking smaller loans from table banking which do not have meaningful impact on our farming activities*".

Confidence in extension service offered to farmers not only provide transfer of knowledge but guaranteed farmers confidence in implementation and sustainability of these technologies. This is because their attitude and perceived behavioral control positively and strongly changes, hence influencing adoption of CSA practices. The role of quality extension service offered should not be underscored as evident in the multiple CSA practices adopted and as noted by (Gbetibouo, 2009) that irregularities of extension services constitute the major factors that challenge adoption of practices. Support of extension service was evident through the confidence level the farmers had with the quality and confidence of extension services offered to them and our results were consistent with (MoLAF 2016) report that indicated there is considerable support from various institution including, non-governmental organization, national government and county government who offered extension service, training and other support service in Taita Taveta – Kenya.

Market accessibility was also analyzed, by accessing mode of transport and trekking distance, the results indicated that 66% of the respondent trek to the market carrying farm produce on their head, making market accessibility a challenge, this concurs with (Ndiritu et al., 2014) who found that trekking distance also affects market access and by extension transportation. This not only deter production but also consume valuable time needed to do other farming activities hence reduced productivity. The support of national government, through provision of access roads to the markets and other infrastructure act as a catalyst to adoption of climate smart agriculture practices, not only do infrastructure improves access to markets and other services, through roads, communication and dissemination of information but opens new up markets and guarantees sustainability of these technologies. Provision of subsidized farm input is critical to success of any technology, with 54.01% indicting to have access to subsidized farm input at implementation stages, this is consistent with the result which showed multiple adoption of CSA technologies in Taita Taveta County.

5.4 Weather Stress perception

In order to assess the weather stress perception, as key indicator of climate change and influence to adoption rate of CSA, the respondent experience a range of weather -related challenges some of which include unpredictable rainfall, increase of pest and diseases, water scarcity, flooding and drought. These factors not only limit agriculture production, but threaten food security and live

hood. From the study 95.2% indicated increase in pest and disease, 86% indicted rains come late, 78.3% experience water scarcity while 87.5% perceive that climate has changed. These result concur with (IPCC 2007) report that stated that climate change, lead to increased pest and diseases, reduced crop yields, drought incidence and increased in water scarcity.

5.5 Climate Smart Agriculture

The key dependent variables access in this study included, agroforestry, mixed farming, crop rotation, livestock improvement, crop improvement, minimum tillage, irrigation, use of organic manure and water harvesting methods. 96% of the respondent practice mixed farming as they are able to get food and supplement the same for organic manure, 82.7% practice agroforestry since these practice provide food, fire wood, building timber for their construction, windbreaks, soil improvement and live hood.

On adoption of irrigation 63.5% of respondent indicated to have not adopted these technologies, due to water scarcity for irrigation as these confirms study by Peterson (2014) who noted that the main barriers to CSA practice adoption were lack of sufficient financial capital and water scarcity for irrigation. 68.30% of the respondent indicated that they harvest rain water an indication of water scarcity in the regions, hence affecting adoption of irrigation technologies like drip irrigation or use of sprinklers being promoted in Taita Taveta.

5.6 Conclusion & Policy Recommendations

General lack of off -the -cuff adoption of climate smart agriculture among small holder farmers has been a major concern to several scholars. A number of research work had been done in attempt to understand characteristics influencing or impeding adoption of CSA and its continued utilization and up-scaling by small holder farmers. Most research work have predominantly concentrated on socioeconomic factors and little on psycho-social characteristic influencing the adoption of climate smart agriculture and other sustainable agricultural practices towards realization of three pillars of climate smart agriculture, which are increased productivity, adaptation and mitigation (reduce greenhouse gas emission).The study adopted an integrative approach in understanding how psycho social characteristic, social economic and institutional characteristic influence adoption of climate smart agriculture in Taita Taveta County, Kenya. The study found out, there is no significant difference between socioeconomic, institutional characteristic and adoption of climate

smart agriculture practices in Taita Taveta Kenya. However, some psycho-social, social economic and institutional characteristic were found significant in adoption of various climate smart agriculture practices by small holder farmers in the region. Psycho-social characteristic, mainly perceived behavioral control and attitude of farmers towards adoption of CSA, were positive and significant predictors of farmer's intention to adopt CSA technologies. Similarly, socioeconomic characteristics such as social capital (farmers joining group membership), farm income, credit access, availability of water for irrigation were likely push factors to adoption of some of these CSA technologies. Institutional characteristics, such as confidence in extension service offered, support by the national government, input subsidies to ensuring implementation and sustainability of the CSA technologies were found to influence adoption of climate smart agriculture. A holistic and interdisciplinary approach should then be used and be part of an effective policy strategy for promoting CSA among small holder farmers focusing on, psycho-social, social-economic and institutional characteristic.The sstrategies to improve adoption and up-scaling rates could include: having tailored made extension service that is agro-ecological specific, tailored made farmer insurance packages for farmers, continuous technical support and follow-up after implementation of these technologies by both public and private sector partners and strengthening farmer's organization groups, who plan key role in information transfers within peers. Lastly to increase productivity on both animals and crops, innovation towards improved breeds and crop varieties that can do well on specific agro-ecological zone should be encouraged and more emphasis on soil testing and establishment of farmers trail plots that can serve as real time training grounds for small holder farmers.

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APPENDICES

MASTER OF MANAGEMENT IN AGRIBUSINESS

QUESTIONNAIRE

Interview No: ……. Date ……. Enumerator:……

Sub-County:…….Ward:……..

Introduction: My name is ……. And or on Behalf of /I am a Master Student at Strathmore University Business School. In partial fulfillment of the requirement for the Degree of Master of Management in Agribusiness, we are conducting a research in Taita Taveta County on **Assessing the Psycho-Social, Social-Economic and Institutional Characteristic Influencing the Adoption of Climate Smart Agriculture Practices in TaitaTavata County -Kenya**. We would like to get your permission to ask you some questions about your participation in the Climate Smart Agriculture practice/technologies. All information will be analyzed anonymously and treated with utmost confidentiality. Thank you.

Name of the Sub Ward: .....

GPS reading of house hold: .....

Name of the house hold head: .....

Variables Names	VARIBLES DESCRIPTION	
Sub County	Sub-County	
Ward	Ward-01	
SE_Gender	Gender of Household Head	
SE_Age	Age of Household Head	
SE_mStat	Marital status Household Head	
SE_Educ	Number of years in schooling for the household head	
SE_hhSize	Number of household family members	
SE_FIncome	Off farm income	
SE_NLowner	The total value of Non-Land Assets owned by the household in (000'KShs)	
SE_fGroup	Farmers group membership	
Institutional Characteristic:	DESCRIPTION	
IC_Credit	Access to credit	
IC_Market	Market Access	
IC_Distan	Walking distance in minutes to the market	
IC_ConfExT	Confidence in Extension Services Offered	
IC_NGovtSprt	National Government Support	
IC_CGovtSprt	County Government Support	
IC_NGOsprt	NGO support	
IC_subInpts	Access to subsidized farm input support e.g. Fertilizer/seeds /seedlings	

Farm Characteristic: CONTROL	DESCRITION	
FC_FSize	Farm size in Acres	
FC_Income	Farm income	
FC_Cattle	Number of cattle	
FC_Sheep	Number of Sheep	
FC_Goats	Number of Goats	
FC_Chicken	Number of Chicken	
FC_Rabbits	Number of Rabbits	
FC_Maize	Maize production per year in tonnes	
Fc_Beans	Beans production per year in tonnes	
FC_Vegetab	Vegetables production per year in tonnes	
FC_Potatoes	Potatoes production per year in tonnes	
FC_AgroLtn	Agro ecological location	
Fc_TrekDtn	Time in minutes taken to walk to the farm	
FC_Wildlife	Incidence of human wildlife attack	
FC_Manure	Use of organic/green manure	
FC_WaterAv	Irrigation water availability	
FC_Weather	Early weather warning system	
FC_RainIndex	Rains came on time/ends on time during planting/crop period	
FC_Pest	Experience pest and diseases increase	
FC_WaterScty	Experience Water Scarcity	
FC_Floods	Experience Floods	
FC_ClimateCH	Perceive climate has changed	
FC_Drought	Experience drought	
CSA_AgroF	Agroforestry	

CSA_MixedF	Mixed Farming	
CSA_CropRN	Crop Rotation	
CSA_LivstImpt	Livestock Improvement	
CSA_CrpImpt	Crop Improvement	
CSA_MTillage	Minimum tillage	
CSA_ConsAgr	Conservation Agriculture	
CSA_OrganicM	Organic manure	
CSA_RainWH	Rain Water Harvesting	
PSYCHOSOCIAL CHARACTERISTICS		
ATT1	I think CSA increases my crop yield	
ATT2	I think CSA increase farm income	
ATT3	I think CSA reduces climate change	
ATT4	I think CSA improve my reputation in the community	
SN1	Most farmers important to me apply CSA on their farms	
SN2	People important to me would think that using CSA would be good idea	
SN3	Most farmers in my community expect me to use CSA on my farm	
SN4	When it comes to choosing farming practice, I want to be like other farmers in my community	
PBC1	I would be able to practice at least one of CSA	
PBC2	I have resources to implement CSA	
PBC3	I have the knowledge to try out or practice CSA	
INT1	I intend to use CSA	

INT2	I will try to adopt at least one of the CSA	
INT3	I am planning to adopt CSA	
WP1	I have noticed change in weather patterns / extreme weather	
WP2	I have noticed drop in rains/ /Heavy rains/floods	
WP3	I have noticed change in weather patterns/season change	
WP4	I have noticed hot/dry weather /drought and high temperatures	
WP5	I have noticed land slide/mudslide and erosion	
WP6	I have noticed drop in water levels	

Respondents will be asked to rate their agreement to the above statement on all the measurement items using a Likert scale of 1-5, with 1 been strongly disagree and 5 strongly agree.

Evaluation of the interview and farm practices

How do you assess the reliability of the responses provided by the interviewed person?

1 if reliable 0 if not reliable:…………………………………………………………….

What important observation can you make about the farmer's field? (Briefly describe evident CSA practice on the farm. Photos are encouraged if the farmer allows you to take them)

,,

,,,

,,,

,,,

,,,

Enumerator please thank the respondent for the information provided and time allowed for the interview.

Strathmore UNIVERSITY

8th June 2021

Mr Mwaghania Godino,
mwaghania.godino@strathmore.edu

Dear Mr Mwaghania,

RE: Assessing Psycho-Social and Socio-Economic Factors that Influence and Affect Adoption of Climate Smart Agriculture in Taita Taveta County, Kenya.

This is to inform you that SU-IERC has reviewed and **approved** your above **SU- master's** research proposal. Your application reference number is **SU-IERC1028/21**. The approval period is **8th June 2021 to 7th June 2022.**

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 SU-IERC.
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 SU-IERC within 48 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 reported to SU-IERC within 48 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to SU-IERC.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://research-portal.nacosti.go.ke/ and also obtain other clearances needed

Yours sincerely,

for: Dr Virginia Gichuru,
Secretary; SU-IERC

Cc: Prof Freed Were,
Chairperson; SU-IERC

Ole Sangale Rd, Madaraka Estate, PO Box 59857-00200, Nairobi, Kenya. Tel +254 (0)703 034000
Email admissions@strathmore.edu www.strathmore.edu

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR
SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **814042**

Date of Issue: **25/June/2021**

RESEARCH LICENSE

This is to Certify that Mr., GODENO MWASARU MWAGHANIA of Strathmore University, has been licensed to conduct research in Taita-Taveta on the topic: Assessing Psycho-Social and Socio-Economic Factors that Influence and Affect Adoption of Climate-Smart Agriculture in Taita Taveta County, Kenya. for the period ending : 25/June/2022.

License No: **NACOSTI/P/21/11232**

814042

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR
SCIENCE,TECHNOLOGY &
INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document,
Scan the QR Code using QR scanner application.

MINISTRY OF EDUCATION
State Department of Early Learning and Basic Education

Telephone:0722160832
Email: cdetaitataveta2@gmail.com
cdetaitataveta2@yahoo.com

COUNTY DIRECTOR OF EDUCATION,
TAITA TAVETA,
P.O BOX 130 - 80305,
MWATATE.

When replying please Quote
Ref No. TTC/EDU/R.2/VOL.2/47

7th July, 2021

TO WHOM IT MAY CONCERN

RE: RESEARCH AUTHORIZATION –GODINO MWASARU MWAGHANIA

License No: **NACOSTI/P/21/11232** by National Commission for Science, Technology and Innovation dated 25th June, 2021 refers.

Authority has been granted to carry out a research on '***Assessing Psycho-Social and Socio-Economic Factors that Influence and Affect Adoption of Climate-Smart Agriculture in Taita Taveta County'*** for the period ending 25th June 2022.

On completion of the research, you are requested to submit a hard copy of the research report/thesis to our office.

COUNTY DIRECTOR OF EDUCATION
TAITA TAVETA
P. O. Box 130 - 80305,
MWATATE

WANJOHI S. MWANGI,
COUNTY DIRECTOR OF EDUCATION,
TAITA TAVETA.

Cc: The County Commissioner,
TAITA TAVETA.

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT
MINISTRY OF INTERIOR AND COORDINATION OF NATIONAL GOVERNMENT

County Commissioner's Office
Taita Taveta County
P.O. Box 1 - 80305
MWATATE

Email Address: cctaitataveta@yahoo.com
When replying please quote:
REF: CC/TVT/ADM.5/VOL.II (128)

7th July, 2021

Deputy County Commissioners
- ✓ Mwatate Sub County
- ✓ Taita Sub County

TAITA TAVETA COUNTY

RE: RESEARCH AUTHORIZATION- GODINO MWASARU MWAGHANIA

Reference is made to a letter Ref.NO.814942 and Licence No. NACOSTI/P/21/11232 dated 25th June 2021 from the Director General/National Commission for science, Technology and innovation on the above subject matter.

The above named student of Strathmore University has been authorized by this office to carry out a Research on ***"Assessing Psycho-Social and Socio-Economic Factors that Influence and Affect Adoption of Climate Smart Agriculture in Taita Taveta County, for the period ending 25th June 2022.***

Kindly accord him the necessary support.

COUNTY COMMISSIONER
TAITA TAVETA
P. O. Box 1 - 80305
MWATATE

RHODA N. ONYANCHA
COUNTY COMMISSIONER
TAITA TAVETA

Cc
Director General
National Commission for Science Technology & Innovation
P.O. Box 30623 – 00100
NAIROBI. – Your letter ***Ref. No.814942 and Licence No. NACOSTI/P/21/11232 dated 25th June 2021 refers.***

The County Director of Education
TAITA TAVETA

GODINO MWASARU MWAGHANIA –***On completion of the research, you are requested to submit a hard copy of the research report to this office.***

PARTICIPANT INFORMATION AND CONSENT FORM

Proposed Study: **Assessing Psycho-Social, Socioeconomic and Institutional Characteristic that Influence Adoption of Climate Smart Agriculture in Taita Taveta County, Kenya.**

SECTION 1: INFORMATION SHEET

Investigator: Godino Mwasaru Mwaghania: **Institutional**: Strathmore Business School (SBS)

SECTION 2: INFORMATION SHEET–THE STUDY

Why is this study being carried out? For partial fulfillment of the requirements for the Degree of Master of Management in Agribusiness and to Provide County Government of Taita Taveta with appropriate policy Strategy.

Do I have to take part? No. Taking part in this study is entirely optional. If you decide to take part, you will be asked to complete a questionnaire on the Topic under Study. If you are not able to answer all the questions successfully the first time, you may be asked to sit through another informational session for a second attempt. You are free to decline to take part in the study from this study at any time without giving any reasons.

Who is eligible to take part in this study? Small holder farmer house hold head, Key informants i.e. Administration /extension workers, Research Assistants and Principle investigator–**Mr. Godino Mwasaru Mwaghania**

Who is not eligible to take part in this study? Minors and those with mental challenges

What will taking part in this study involve for me? You will be approached by our trained Research Assistant _____and requested to take part in the study. If you are satisfied that you fully understand the goals behind this study, you will be asked to sign this information consent form and then taken through a questionnaire.

Are there any risks or dangers in taking part in this study? There are no risks in taking part in this study. All the information you provide will be treated as confidential and will not be used in any way without your express permission.

Are there any benefits of taking part in this study? The information will be used to improve the uptake of the climate smart agriculture practices /technologies in the region with intention of improving food security, and reduce /mitigate climate change in and to some extend minimize human wildlife conflict and for strategic policy development within the county of Taita Taveta.

What will happen to me if I refuse to take part in this study? Participation in this study is entirely voluntary and no consequence will be taken against you /result from opting out or withdrawing from the study.

Who will have access to my information during this research? All research records will be stored in securely locked cabinets. That information may be transcribed into our database but this will be sufficiently encrypted and password protected. Only the people who are closely concerned with this study will have access to your information. All your information will be kept Confidential.

Who can I contact in case I have further questions? You can contact, **Godino Mwasaru Mwaghania** at SBS, or by mwaghania.godino@strathmore.edu or by phone (+254714309797). You can also contact my supervisor, **Prof. S. Wagura Ndiritu PhD,** SBS, Nairobi, or by e-mail **sndiritu@strathmore.edu** or by phone (+254 722590559).

If you want to ask someone independent anything about this research, please contact:

The Secretary–Strathmore University Institutional Ethics Review Board, P. O. Box 59857, 00200, Nairobi, Email ethicsreview@strathmore.edu Tel number: +254 703034375

I, _____, have had the study explained to me. I have understood all that I have read and that explained to me and had my questions answered satisfactorily. I understand that I can change my mind at any stage.

Please tick the boxes that apply to you; Participation in the research study

- I AGREE to take part in this research (Yes/No): _____ (*tick appropriate answer)*
- I AGREE to have my completed questionnaire stored for future data analysis (Yes/No): _____ (*tick appropriate answer)*
- Participant's Signature: _____

Date: _____/_____/_____DD / MM / YEAR Participant's Name: _____

Time: _____ /_____ (Please print name) HR / MN

I, _____ (Name of person taking consent) certify that I have followed the SOP for this study and have explained the study information to the study participant named above, and that:

S/he has understood the nature and the purpose of the study and consents to the participation in the study.

S/he has been given opportunity to ask questions which have been answered satisfactorily.

Investigator's Signature: _____

Date: _____/_____/_____DD / MM / YEAR

Investigator's Name: _____

Time: _____ /_____ (Please print name) HR / MN