AN ANALYSIS OF PUBLIC-PRIVATE- PARTNERSHIP IN THE PROVISION OF AGRICULTURAL EXTENSION SERVICES: THE CASE OF GREENHOUSE TOMATO GROUPS FARMING IN SAMBURU COUNTY, KENYA

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DECLARATION

I, Njeru Patrick Ndwiga, declare that this thesis is my original work and has not been presented to any other institution for the award of a degree.

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DEDICATION

This thesis is dedicated to my wife Emily and daughters Shirleen and Princess, my parents Mr and Mrs Nicholas Njeru Njoka, as well as my siblings for their support, encouragement and guidance that has enabled me to be the person I am today.

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ABSTRACT

Agriculture has wide ranging global impacts which extend to economic growth, poverty reduction, food security, livelihoods, rural development and environment management. A consensus exists that extension services, if functioning effectively, improve agricultural productivity. Agricultural extension services provide farmers with important information, such as patterns in crop prices, new seeds varieties, management practices with respect to crop cultivation and marketing, and training in new technologies. By improving the knowledge base of farmers they increase the ability of farmers to optimize the use of their limited resources and, eventually, increase in yields. In light of this, the costs, to the state, of having underachieving extension service–in terms of productivity of smallholders, incomes and reduction in poverty-are very high. A number of agricultural extension models have, in the past, been employed with varying levels of success in developing countries including Kenya. The present study sought to analyze and document the effectiveness of the public-private-partnership (PPP) model of provision of agricultural extension services. Additionally, the study sought to determine the constraints to greenhouse tomato production in the county. The survey utilized a cross sectional study design with the entire population of greenhouse tomato farmers' groups in Samburu county, Kenya, being enrolled in the study. Primary data were collected from 20 greenhouse tomato farmers' groups and agricultural extension services providers (AESPs). Secondary data were abstracted from records maintained by the farmers and the funding organizations. Statistical analysis was done using IBM SPSS Statistics version 22. This involved computing descriptive statistics such as frequencies and the corresponding proportions, means (±standard deviations) as well as medians (interquartile range). Inferential statistics were derived from independent t-tests, analysis of variance (ANOVA) and chi square (χ^2) tests. To assess associations between categorical variables, χ^2 tests were conducted. Additionally, t-tests and ANOVA were deployed while comparing continuous outcomes in two groups and more than two groups, respectively. In total, the study evaluated twenty greenhouses owned by twenty farmer groups. The farmer groups were served by five different agricultural extension service providers (four under public while those under private and PPP were eight in each case). The total tomato yields assessed in the season preceding the survey were 3.14, 15.06 and 15.27 tonnes, respectively, for public, PPP and private models. The mean yields per greenhouse varied significantly by the various models assessed (786.3±180.7, 1881.9±283.5 and 1909.1±213.5 kilograms corresponding to the public, PPP and private models respectively, ($F_{2,\ 19} = 34.200$, $p<0.001$). In particular, mean tomato productivity in greenhouse units under public model were statistically significantly less when evaluated against those under PPP model of extension service provision by a mean of 1095.6±147.0 kilograms ($p<0.001$). Contrary to this, greenhouse units under private and PPP models were not statistically significantly different in tomato productivity ($p=0.972$). These variations mirrored the levels of adoption of modern agricultural practices and technologies in the three models of extension services provision. Shortage of water for irrigation, pests and diseases, local unavailability of the improved varieties of seeds and marketing challenges were the most frequently cited constraints to greenhouse tomato farming. The current study provides further evidence that PPP model of delivery of agricultural extension services may be the panacea to the ailing public agricultural extension services. The study also indicates that even where farmers are willing to adopt modern agricultural practices and technologies, they may have no access to them. There is a need to explore ways of creating effective operational linkages between AESPs and other key stakeholders such as input suppliers, credit and research institutions among others.

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LIST OF ABBREVIATIONS AND ACRONYMS

AATF	African Agricultural Technology Foundation
ASDS	Agriculture Sector Development Strategy
ATMA	Agricultural Technology Management Agency
CBOs	Community Based Organizations
CDD	Community Driven Development
CDF	Constituency Development Fund
CDM	Catholic Diocese of Maralal
AESPs	Agricultural Extension Services Providers
FAO	Food and Agriculture Organization
FBOs	Faith Based organization
FFS	Farmer Field Schools
GoK	Government of Kenya
IMF	International Monetary Fund
KAPAP	Kenya Agricultural Productivity and Agribusiness Project
MoA	Ministry of Agriculture
PPP	Public-Private Partnerships
SAPs	Structural Adjustment Programmes
SPs	Service Providers
T&V	Training and Visit
WB	World Bank
WEF	World Economic Forum

CHAPTER ONE: INTRODUCTION

1.1 Introduction

A general consensus exists that extension services in agriculture, if well designed and executed, improve productivity and greatly impact, in a positive manner, the livelihoods of farmers especially the smallholder ones (Evenson and Mwabu 1998; Babu et al 2013). Katz (2002) argues that the extension services support families in rural areas to make the best use of the resources available to them. Agricultural extension services generally provide farmers with vital information, including patterns in produce prices, new or improved varieties of seeds, management practices regarding crop cultivation as well as marketing, in addition to training in upcoming technologies (Akinwale et al 2016). Extension services advance the knowledge and information base of the farmers through an assortment of means, including demonstrations, targeted trainings, model plots plus group meetings. The exposure to such extension activities is mainly intended to boost the capacity of farmers to optimize the utilization of their resources ultimately leading to improvement in crop yields. Additionally, extension services, ideally, should avail a feedback mechanism, specifically, from the farmers to the agricultural research centres. It has also been noted that even where agricultural technologies are affordable, relevant and easily available, smallholder farmers may have little access to them (Fliegel 1993). For this reason, agricultural extension systems and the distribution systems of inputs are mutually reinforcing. This implies that the contribution of extension services to overall agricultural productivity growth relies on a properly functioning input distribution system and vice versa. Besides, agricultural technologies are changing at a very rapid rate. There is, thus, a need for farmers to be constantly informed of upcoming technologies and what works best (World Economic Forum (WEF) & McKinsey & Company, 2013.). Moreover, they should know how to

strategically employ those technologies to their advantage. Generally, such awareness creation generates demand for the most viable upcoming technologies which in turn signals the distribution system to supply the requisite inputs (Davidson et al 2001).

Globally, the agricultural extension service provision has not been free from challenges. The key challenges are: low coverage, lack of appropriate, affordable and relevant technologies, unfavourable policy environment for the enhancing agriculture and/or rural development. Others include poor institutional arrangements and incompetent institutional support services that include lack of credit facilities, supply of inputs and agricultural markets, lack of political goodwill and commitment and scarcity of funds (Desai et al, 2011). For the widely deployed public sector extension system, enhancing its efficiency, effectiveness and relevance in meeting its objectives and goals remains unresolved (Glendenning et al, 2010; Desai et al, 2011).In a bid to solve the problems, experts are always looking for applicable and sustainable solutions (FAO, 2016).

With respect to this, there are emerging views on models of agricultural extension services that are no longer based on a unified service and, most importantly, a top-down approach. It is a network of information and knowledge support tailored to the needs of rural communities (Babu et al, 2013). Such views advocate for a model of extension that is viewed within the larger rural development agenda (based on fact that the social, market and environmental production systems require a differentiated set of extension services) (Wilson et al, 2014). This encompasses a stage of transformation -from the stage of innovation to execution as well as provision of a menu of options for invention, innovation, investment and information. As a result of consideration of such views and, assuming a consensus is reached, there are policy changes that a state should undertake considering their unique conditions. Governments, for instance, may act by defining,

documenting and implementing a coherent agricultural extension policy for the pluralistic system (Brickell and Elias 2013). The pluralistic knowledge extension system, in general, includes growth of several service providers, decreased public sector responsibilities, change in the nature of research and structure of the overall agricultural sector (Demisse et al, 2014). The main actors involved in establishing a partnership in the delivery of agricultural extension services include the government, private sector, civil society and NGOs (WEF and McKinsey & Company, 2013).

Kenya has a lengthy history of publicly funded agricultural extension services. Indeed, the government was, in the past, solely responsible for the provision of agricultural extension services via the Ministry of Agriculture. The total number of technical staffs who were engaged in agricultural extension in 2011 was approximately 5470, distributed countrywide (Monitoring Evaluation Assistants (MEAs) report (2011). This was a drop in the ocean in light of the fact that the vast majority of Kenyans are engaged in smallholder farming activities. It has been observed over time that public agricultural extension services linked with agricultural production objectives and all-purpose recommendations can no longer meet farmers' expectations. Therefore, agricultural extension practitioners need to address this challenge by enhancing participation of the private sector in the resource mobilization and delivery of agricultural extension services.

Kenya’s smallholder farmers have generally traditionally benefited from two types of agricultural extension systems. First is the public/government extension system. Since independence, the Government of Kenya Ministry of Agriculture has played a pivotal role in extension services, with a special focus on food crops. The Ministry has implemented a variety of extension styles and models, such as progressive/model farmer approach, rural development

approach, farm management, integrated agricultural, training and visit (T&V). Other models and styles include attachment of extension officers to selected organizations, and farmer field schools (FFS) and farming systems approaches (Government of Kenya (GOK), 2010). Nevertheless, these extension approaches have been associated with varying levels of success.

The second type of agricultural extension system comprises of the commodity-based approaches that are run by government parastatals, cooperatives and also out-grower companies. These commodity-based agricultural extensions involve transacting, mainly but not exclusively, with major commercial crops for example, tea, pyrethrum, coffee and sisal. These approaches to agricultural extension services are motivated by profits. They tend to function well when the farmers and the firms involved evidently benefit from the agricultural extension expenditures. As such, all facets of producing and marketing a given commercial crop are comprehensively vertically integrated. The integration spans the entire range from advice, research and inputs provision to farmers, to ultimately processing and organizing marketing including exports.

Following the enactment of structural adjustment programmes (SAPs), the Government of Kenya, just like other involved African governments, was put under substantial pressure to drastically scale down its central role in the economy (FAO 2013). Since then, the government's agricultural extension budget coupled with extension officers' numbers have gone down considerably. Budgetary allocations for agricultural extension services have reduced from about 6% of the overall government budget in the first two decades of independence to less than 2% currently (Republic of Kenya 2005). During this period, the performance of the agricultural extension service in Kenya was put into question with its overall effectiveness becoming a controversial subject (Gautam and Anderson 1999). The traditional public agricultural extension system was seen as uniform (one-size-fits-all), top-down, paternalistic, inflexible, and outdated

and subject to government's bureaucratic inefficiencies. As a result of this, it was largely unable to cope with the modern agriculture and its dynamic demands (FAO, 2013).

There has been a constant desire to reform the public agricultural extension system into a system that is responsive to the needs of farmers, accountable, cost effective, broad-based in delivery of services and with an inherent sustainability. Furthermore, there has been a call for increased involvement of beneficiaries at grass roots as well as major stakeholders. As a result of these concerns, a third system of agricultural extension service has emerged: the privatized extension initiatives championed by non-governmental organizations (NGOs), community-based organizations (CBOs), private companies, and faith based organizations (FBOs).

Agricultural extension is now broadly perceived as a composite system where services are provided by a range of both public and private sector entities (Ragasa et al 2013; FAO, 2016). The major players in agricultural extension today are the farmers' groups, bilateral organizations such as FAO, international research organizations such as International Livestock Research Institute(ILRI), donors such as United States Agency for International Development (USAID), government, NGOs (Red Cross, World Vision), private companies such as Brookside Limited company and community-based organizations. While many have distinct roles, they often overlap in the delivery of services in addition to working in partnerships. The efficiency, effectiveness and responsiveness of the emerging multi-provider (pluralistic) extension models remain largely undocumented. In particular, there is inadequate understanding and limited literature on public-private partnerships (PPPs) in agricultural extension services provision and specifically to small scale farmers in resource poor settings (GOK, 2010). The current study sought to address this dearth of information by analyzing the PPP in the provision of agricultural extension services in Samburu County. The study focussed on partnership in the area of

greenhouse tomato production in the county. This involves the Ministry of Agriculture, World Vision, Farm Africa, Catholic Diocese of Maralal and Red Cross Society.

1.2 Statement of the Problem

To unleash the potential of the agricultural sector for poverty alleviation and sustainable development in developing countries like Kenya, high capital investments are needed. Unfortunately, in most of these countries public budgetary allocations to the sector have been dwindling over time hence slowing its growth and stifling the potential (Brickell and Elias 2013; FAO 2016). The declining effectiveness of the extension services in agriculture in Kenya has been identified as a great impediment to the growth of this industry (Milu and Jaynef, 2006). Indeed, the public extension systems in many countries, including Kenya, have not been able to address the issues and concerns of smallholder and poor farmers (FAO 2016). Moreover, majority of smallholder farmers and other vulnerable groups remain unreached by the public extension system (Babu et al, 2013). The performance of the agricultural sector has thus perpetually underperformed in terms of productivity and its ability to transform the livelihoods of smallholder farmers. As a result, the search for new extension models that are more effective, efficient and responsive to the needs of farmers is essential. While available experiences and anecdotal evidence from several countries suggest that PPPs can enhance the productivity of the agricultural sector, it would be beneficial to have some more hard facts and figures in this regard. The current study adds to the growing evidence base on the effectiveness of PPPs.

1.3 Objective of the study

1.3.1 General Objective

The general objective of the study was to analyse the public-private-partnership in the provision of agricultural extension to greenhouse tomato farmer groups in Samburu County.

1.3.2 Specific Objectives

(i) To describe practices of farmers under three different agricultural extension service provision models (private, public & public-private partnership) in Samburu County

(ii) To compare the three models of agricultural extension service providers (AESPs) with respect to efficiency of agricultural extension services in Samburu County

(iii) To document constraints to greenhouse tomato production in Samburu County

1.4 Research questions

(i) What are the practices of farmers under different extension service provision models (private, public & public-private partnership) in Samburu County?

(ii) How do the three models of extension service providers compare with respect to effectiveness of agricultural extension services in Samburu County?

(iii) What are the constraints to greenhouse tomato production in Samburu County?

1.5 Justification of the study

The context of the systems of farming, agro-ecological conditions, market infrastructure and the socioeconomic, cultural and political environment, shape the definite model of agricultural extension service provision. Given the enormous diversity of contexts across the globe, it is natural that a myriad of models of agricultural service delivery and their variants are a reality.

The strength of the agriculture sector to alleviate hunger and poverty is well recognized (Babu et al, 2013). Agricultural extension provision plays a crucial role in agricultural development especially in rural settings. Indeed, it serves as a tool for the providing education and informing the farming community about modern technologies and improved production techniques along with prudent use of resources. Besides, engagement in agricultural extension avail a two-way mechanism of information exchange between farmers and agricultural research stations (Bajwa, 2004). Considering the potential of these services, it is judicious that we constantly seek evidence based strategies aimed at strengthening and enhancing their provision to the farming community.

Against a background of limited government resources and expertise, innovative partnerships that bring together business, government and civil society actors are increasingly being promoted as a mechanism for improving productivity and driving growth in agriculture and food sectors around the world (FAO, 2016). The PPP model of provision of agricultural extension services is being advocated as a road map to achieving accelerated economic growth, infrastructure development and delivery and to achieve quality service delivery and good governance. The present study sought to document the effectiveness of PPP model of agricultural extension in an area where food security, securing livelihoods and reduction of poverty are major concerns (Brickell and Elias 2013). The findings generated from this study contribute to the growing evidence that PPPs could be utilized in the design and implementation of agricultural extension services that are effective, demand-driven and tailored to the peculiarities and realities of the Sub-Saharan context.

CHAPTER TWO: LITERATURE REVIEW

2.1 History and evolution of extension services in Kenya

The current agricultural extension system in Kenya is as a result of gradual evolution in extension management practices (GoK, 2012). Provision of agricultural extension before 1980 was solely by the government and the entry of private agricultural extension service providers was as a result of changing economic policies that saw a marked reduction in funding of the public extension service provision by the government (GoK, 2012). This was particularly after the structural adjustments programmes (SAPs) that were put in place by the World Bank (WB) and International Monetary Fund (IMF) in the 1980s that called for a reduced funding for the agriculture budget and employment of extension staff by the Kenyan government (FAO, 1997). These private providers comprised private companies, Faith Based Organizations (FBOs), NGOs, and Community Based Organizations (CBOs) (Rees *et al*, 2000, Nambiro *et al*, 2005).

Non-governmental organizations, CBOs and FBOs emerged as having many comparative advantages when compared to the public extension providers (Kanyinga, 1993). These advantages include their flexibility and cost effective techniques, relatively greater grassroots' level contacts and the increased penchant for projects that are sustainable (Nambiro *et al*, 2005). These advantages have put the organizations at the foreground in numerous donors' eyes (Nambiro *et al*, 2005; Kanyinga, 1993). Indeed, the NGOs, CBOs and FBOs have rapidly expanded to seal the immense gap left by the state. The demand for agricultural extension services from these organizations has hence increased significantly (Omolo *et al*, 2001; GOK, 2010). However, these players have had a myriad of challenges that have compromised their ability to offer agricultural extension in isolation. First, most of them depend on donors to finance their operations and this makes sustainability an issue once the donor pulls out (Ameur,

1994; GOK, 2010). Secondly, NGOs, CBOs and FBOs have also been found to lack in capacity in terms of human resources, technological expertise, facilities and basic infrastructure (Omolo et al., 2001, Sanders and McMillan, 2001). The government extension service provider on the other hand has an edge over the NGOs, CBOs and FBOs in as far as sustainability and capacity in terms of competent staff is concerned. However, with the reduced finances and few staff, the government extension service provider is also not able to work efficiently (GoK, 2012).

The entry of the many AESPs has not completely solved the problems in extension, but has indeed resulted to emergence of new problems. These are the pursuance of individualistic approach by the various AESPs, duplication of efforts and giving contradictory messages to the same farmers (GoK, 2012). There has been a realization that no single institution can improve the livelihood of African farmers alone (African Agricultural Technology Foundation (AATF), 2005). This is especially true because of the reasons mentioned above that give each and every AESPs some advantages and disadvantages when compared to the other.

2.2 Private system of Provision of agricultural extension services

Bloome (1993) states that private system of agricultural extension comprises of any organization or person in the private sector who is involved in the delivery of agricultural advisory services and is seen as an alternative to public agricultural extension system. It also consists of agencies and organizations that get funds from government and other donors for implementing extension programmes and they are mostly of 'not-for-profit' type (Mukherjee and Maity, 2015)). Some of the most common approaches in private agricultural extension services system include share cropping system, consultancy firms, contract farming system, input cum advisory extension, voucher system agribusiness cum extension and clinic based extension. Private firms typically

focus on a particular type and/or levels in the value chain, for instance; use of inputs, prevention and/or control of diseases, harvest and post-harvest techniques/technologies (Kumar and Vijayaragavan 2007). The role of private sector has even increased exponentially in the internet age whereby the increment of value and volume of information has served as an impetus for value addition of services and information provided by, for example, including location specific, time and formats as well as assisting farmers to incorporate this information in their operations (Davis et al, 2010).

Though extension-experts and economists agree that the private extension service system can be successful even in resource limited areas provided especially if there is availability of appropriate technologies and marketing facilities, it should be embraced with caution (Mukherjee et al, 2015. The private enterprises, when they have their own marketable agricultural inputs are desperate enough to convince the farmers so that they use only those products. The situation fools the farmers and compels them to be irrational in the choice of products such as fertilizers and chemicals as well as their use in non-judicious manner, so much so that it raises health hazards and environmental issues (Kumar and Vijayaragavan 2007; Mukherjee and Maity, 2015).

2.3 Public-private partnership and Provision of extension services

Globally, public sector investment in extension has historically driven the changes in the agricultural sector. However, recent trends indicate that, on its own, the public sector's role is not adequate to meet the needs of farmers and thus may not be as significant in the future (Mukherjee and Maity, 2015). One of the main reasons is that the system is highly inefficient, often out of touch with the current needs of the farmers and the already technologies developed take too long to be disseminated to the farming community. The net effect of relying on the

public system is research innovations and developments in the agricultural sector are several decades ahead of the present agricultural practices. On the other hand, total privatization of extension services in agriculture is not advisable. Since the private sector is guided by the private motive, at minimum, the government should play a regulatory role including ensuring the quality of services and goods (Jiyawan et al 2009; Davis et al, 2010). In addition, the private sector is not keen on funding long-term research activities and usually restricts itself to supplementing to strengthen extension system through services and technology support in short term, profit-oriented manner (Glendenning et al, 2010). Noteworthy is that the private sector is averse to the risks involved in investing in rural remote settings and this underscores the importance of maintaining public sector investment in physical and social infrastructure development, poverty alleviation, subsidy and research.

Mukherjee and Maity (2015) contend that with the traditional public agricultural extension system lacking the capacity to deliver as per expectations, the solution to the apparent gap between demand and supply is to engage the private sector as a partner or complimentary stakeholder. The resultant PPP has the potential to promote better utilization of limited resources and, ultimately, boost agricultural production (Ragasa et al, 2013). According to Crop Life International (2012) successful PPPs improve the efficiency of improving use of locally-adapted innovation. They also have the capacity to ensure that technologies are disseminated more effectively to local farming communities, aid farmers in continuous improvement of their practices. Public-private partnerships also have the potential to promote accountable and effective application of modern technologies, help farmers optimize the utilization of sustainable agricultural practices and provide socioeconomic value to communities. For national governments, PPPs offer an extremely effective way to avail timely and relevant tools to farmers,

while, at the same time, assisting in building knowledge in local communities (Davis et al, 2010). On the other hand, collaboration affords, the private sector, an innovative strategy to resource needs including financial ones, and more importantly, develops and opens up potential markets.

Morse (1996) reported increased productivity, reduced poverty, and an improved quality of life as some of the benefits of PPPs. In a study on factors associated with improved extension services through PPP in the District of Kinango, Kenya, Wairoma (2010) reported that agricultural extension services delivered by the private sector, whether funded by government or not, were a progressive feature in all aspects. The research concluded that the sustainability of this form of extension service delivery required investment in staff training and reorientation as well as building of the institution capacities before the establishment of a PPP. It was reported that accountability and good governance among the operating institutions was important as it eliminated suspicion while increasing trust thus creating a favourable environment for smooth inter-organizational operations.

A research study on the PPP for Gadam Sorghum production and marketing in Eastern Kenya showed that breakdown in communication between farmers and the marketing agent, sale to other buyers, labour shortage, conversion of commercial grain into food and provision of poor seeds (that led to reduced supplies to the brewer) were some of the challenges of the PPP arrangement. Nonetheless, the study concluded that proper PPP arrangements could enhance innovation in small holder production (Kavoi et al, 2011).

An examination of the paradigm shift from public to PPPs agricultural extension approach in Pakistan revealed that the most important strength of the PPP in the eyes of farmer respondents was increment in ownership '*managed by farmers' bodies*' **(**Ikram, 2009)**.**

In the evaluation of The Kenya Agricultural Productivity and Agribusiness Project (KAPAP), Ngugi, Muigai and Muhoro (2014) reported that estimated returns to investment based on the KAPAP model was 39.4. Kenya Agricultural Productivity and Agribusiness Project implement an innovative service delivery model in its extension services. The demand driven approaches include community driven development and PPPs through exclusive contracting of service provision. The objective of the KAPAP model is to increase productivity and incomes of smallholder farmers. The evaluation of the model for a period of 15-months also reported growing incomes and extensive capacity building. Besides, quality and quantity of produce were shown to have increased and farmers were well linked to inputs' suppliers, financial institutions and veterinary services which activated a surge in productivity of the enterprises. In particular, the study reported that production of sorghum, local poultry and maize increased by 72%, 83.6 % and 71.6% respectively. Besides, this approach was noted to have raised the participation of farmers (growth in membership from the 63, 839 to 118,865) and also improved participation of women in the project. The achievements were credited to the engagement of the subtle talents and capabilities from the private sector resulting in enhanced complementation of what was already in existence in the public sector.

In a study done in Eastern Kenya, it was noted that the multidisciplinary nature of PPPs helps reduce transaction costs on contracting, coordinating and enforcing relationships between different stakeholders as well as costs associated with forming and sustaining relationships. It was concluded that initiatives that embraced the PPP approach led to higher technology adoption

rates, improved and sustainable farm productivity, increased household food security, incomes, and better standards of living. They also promoted the diffusion and adoption of improved technologies and innovations (Kavoi, Mwangi & Kamau, 2013). In another study, Kavoi et al (2014) showed that PPPs enhanced networking between the farming communities especially where farmers' self-help groups existed. This resulted in increased bargaining power, better marketing of farm produce and it minimized exploitation of farmers by the brokers who meddle with both farm-gate and market prices. The team also noted that PPPs promoted diversification in agricultural production and innovation amongst farmers. For instance the team documented a case of Mwikililye farmers' self-help group, one of the pioneer Gadam sorghum PPP initiative production cells in Migwani Sub-County, Kenya, whereby apart from selling Gadam sorghum to an agent they also sold maize, beans, cowpeas and green grams to schools.

Singh (2008) documented the experiences of a variant of PPP in Agricultural Extension called Agricultural Technology Management Agency (ATMA) Model in Bihar and India. He observed that the model had promoted sustainable agricultural technologies that were eco-friendly in nature. These included integrated nutrient management, increased utilization of water conservation practices and integrated pest management. Organic farming which encompassed a shift from water-intensive crops, e.g., wheat and paddy, to water-extensive crops including maize, floriculture, oilseeds, vegetables and pulses. Also, it had encouraged the usage of micro-irrigation systems. Furthermore, it had contributed to augmented incomes and employment through diversification of agricultural production. Moreover, IIM-Lucknow observed that the ATMA approach had impacted on the incomes and cropping systems in all the implementation districts for the entire project's lifetime spanning four years. Also reported was that the change in the area dedicated to horticultural cropping from 12% to 16%, while an increase from 3% to 11%

in the area allocated to oilseeds production (Department for Agriculture and Cooperation (DAC), 2010). The land allocated to herbs, aromatic crops and medicinal area enlarged (1% to 5%). Rice, wheat and other cereals were allocated a reduced portion of land (55% to 47%). However, yields of cereals went up by 14% hence no considerable loss in production of staple food was observed. It was also observed that during the four-year period, the mean income in districts where the projects were implemented rose by 24% in contrast with an income increment of 5% in the districts where project did not exist (Tyagi and Verma, 2004; DAC, 2010).

Innovative partnerships involving superior businesses, when properly designed, can assist in the delivery of improved services to farmers, e.g., insurance and other finance services. Caution in the provision of such services, nevertheless, has to be exercised. According to OXFAM (2014) PPPs of such gigantic magnitudes are innately a risky affair to implement in sub-Saharan Africa. In these countries, governments have effectiveness of very low levels, in addition to the problematic issues concerned with market regulation. More importantly, challenges abound on the inclusion of the voices of the underprivileged rural communities in policy. Consequently, most of the sub-Saharan Africa countries may have deficiencies in the skills, resources and political goodwill required for such PPPs to be formulated, structured, executed and managed well (Bloomfield & Ahern 2010). In fact, evidence indicates that in contexts where political goodwill is low and governance is poor, PPPs serve as excellent avenues for the political elites to make political gains with corruption also being highly likely (World Bank Institute, 2012).

2.4 Constraints to farming and extension services

The absence of investment in the area of agricultural extension services underlies most of the challenges experienced by the farming communities residing in resource constrained settings such as the study area. Perennial absence of irrigation specifically targeting the small scale

farmers' leaves them relying on the erratic rainfall for agricultural production; reduced state support has occasioned inadequate access to input needed in modern farming (credit, seeds and fertilizer, and extension services). The situation is exacerbated by the fact that when they occasionally produce surplus, these farmers, and particularly those residing in remote rural places, have no access to storage or markets. Human resource is also becoming a challenge with young people being uninterested in agriculture according to a publication by OXFAM (2014). In particular, the low incomes associated with agricultural enterprises coupled with high risk and unsatisfactory gains when compared to the effort required to succeed make the enterprise a very poor proposition for the young people (Umunnakwe et al, 2014).

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter outlines the approaches that were deployed in conducting the research study. The study area, study design, data collection, management and analysis procedures are also highlighted.

3.2 Study area

The study was carried out in four locations of Samburu North and Samburu central Sub-counties of the Samburu County. These are Logorate and Kisima locations in Samburu Central and South Horr and Baragoi locations in Samburu North. The county is located between latitudes 0˚36 and 2˚40 N and longitudes 36˚20 and 38˚20 E. The altitude ranges between 850 – 2400 m above sea level. The area receives rainfall that is mostly erratic, in space and time. The rainfall amount ranges between 250 mm and 850 mm per year. Temperatures differ with altitude with the mean annual minimum temperature being 24˚C while the mean maximum annual temperature is 33 ˚C. In several zones of this county, the layer of soil is thin. The county thus has scanty and sparse coverage of vegetation. The Figure 3.1 shows the map of Samburu county where the study was carried out.

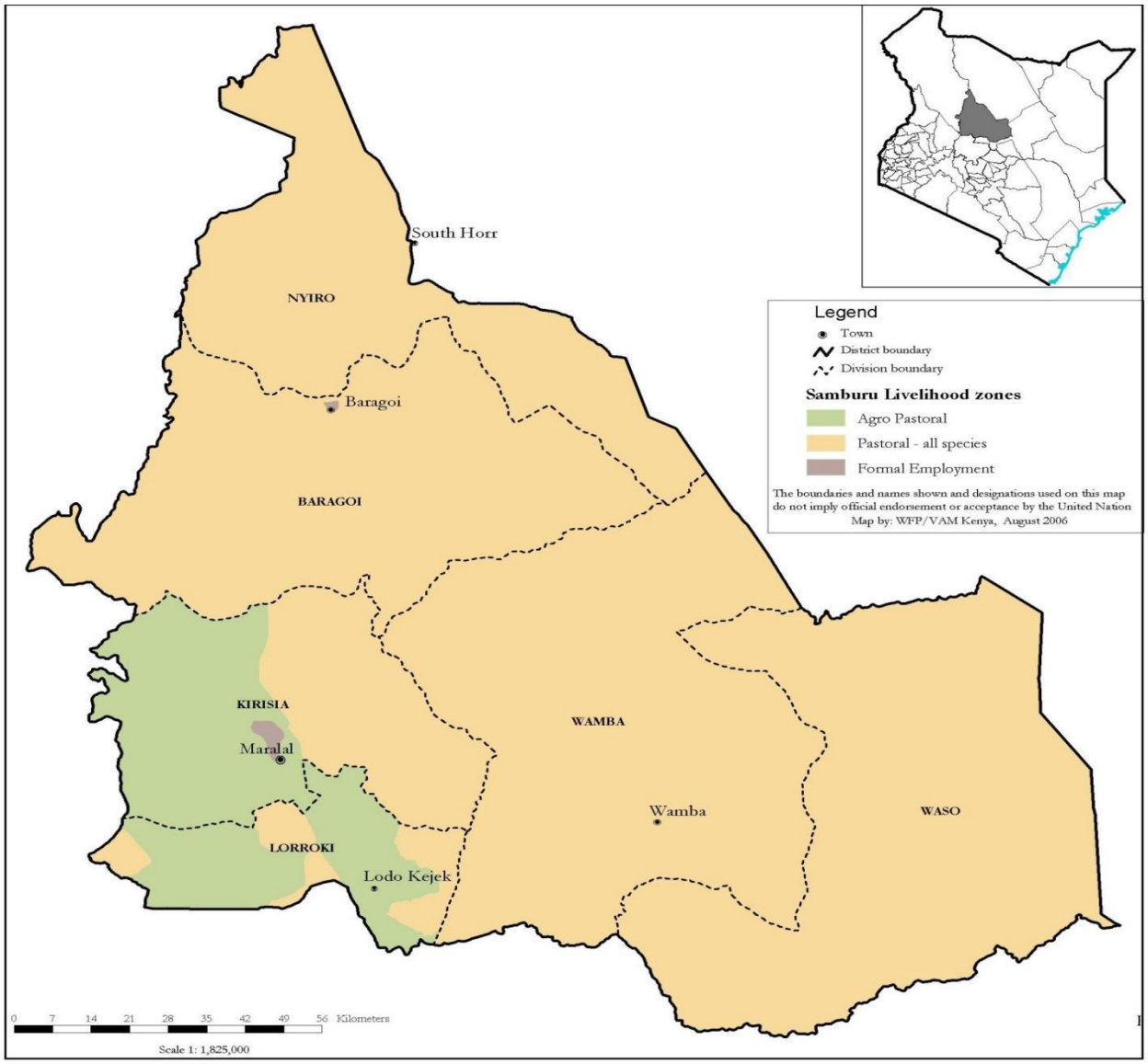

Figure 3. 1 Map of Samburu County 2016 (Source: National Drought Management Authority, Samburu County Office)

Pastoralism constitutes 80% of the county's livelihood zones, with agro-pastoralism constituting the rest. Indigenous livestock breeds that are hardy and resistant to drought and diseases predominate in the region. Rain fed crop farming is concentrated in Lorroki plateau that is in Samburu central sub-county, where rainfall is relatively higher and reliable, ranging between 650 mm to 850 mm per year (MoA, 2013). Maize and beans are the major food crops grown in the area. Promotion of drought tolerant crops such as cowpeas, green-grams and sorghum has been

spearheaded by the Ministry of Agriculture in the recent years. Other food crops include Irish potatoes and vegetables such as cabbages, kales and onions, which are grown on a very small scale. On the other hand, wheat and barley are the major cash crops in the area, and are grown by a few large scale farmers.

Greenhouse tomato farming in Samburu began in 2009 when four farmer groups were funded with greenhouses to produce tomatoes by the constituency development fund (MoA, 2011). Other agricultural development partners namely World Vision, Catholic Diocese of Maralal, Farm Africa and Red Cross society soon followed suit and funded more farmer groups. Realization of full production potential has not been achieved by the greenhouse tomato farmers. The average yield per greenhouse has been estimated at 1.5 tonnes, which is very low (MoA, 2012). The Ministry of Agriculture estimates that local tomato production supplies only about 40% of the requirement, with the rest being met through imports from neighbouring counties. There is therefore more need to develop the greenhouse tomato production in the county.

3.3 Data and data sources

Primary data were collected from, respectively, representatives of the greenhouse tomato farmers and agricultural extension service providers by key informant interviews and observations. Secondary data, including tomato yields, were abstracted from records maintained by the farmers and the funding organizations.

3.4 Data collection tools and data collection methods

The data collection tools used in the study were structured questionnaires, key informant interview (KII) guides, focus group discussion (FGD) guides and observation check lists. Four area agricultural officers were recruited as research assistants, trained on data collection

procedures including interviewing techniques. The tools for data collection were tested in a pilot study and modified appropriately to guarantee understanding and clarity. The pilot study was thus carried out using three tomato farming groups in Kisima location of Samburu Central Sub-county. Using noted observations in the field, appropriate revisions were made on the initial data collection tools. Qualitative data were collected using key informant interviews with representatives from the five agricultural extension service providers, namely the Red Cross Society (PPP), Catholic Diocese of Maralal (Private), World Vision (Private), Farm Africa (PPP) and Ministry of Agriculture (Public) to assess the challenges and opportunities in their partnership while providing agricultural extension services to greenhouse tomato farmers. The quantitative data were obtained from records maintained by the greenhouse tomato farmers and extension service providers using data abstraction forms.

3.5 Population

The study population comprised of all the twenty greenhouses that were dealing with tomato production in Samburu County, Kenya.

3.6 Sampling

The total population of twenty greenhouses was used in the present study. In each of the 20 greenhouses sponsored by various agricultural development partners in the county, a farmer was chosen randomly from the group's membership using computer generated random numbers. Similarly, a representative of each of the agricultural extension service providers was chosen purposively based on being the one who worked with the farmers as the agronomist. For the funding organization that lacked an agronomist, the person selected to participate in the study was an agronomist from the MoA who worked closely with farmers in those particular greenhouses. The providers were requested to take part in the key informant interviews.

3.7 Data management and Analysis

Quantitative data was entered in a Microsoft Access database and then exported to IBM SPSS Statistics v22.0 for statistical analysis. This involved computing descriptive statistics such as means (standard deviations), frequencies and proportions as well as medians (interquartile ranges). Furthermore, statistical analysis that involved deriving inferential statistics using chi square tests and analysis of variance (ANOVA) was done. Mean tomato yields for greenhouses managed by the three different models of agricultural extension provision were compared using ANOVA. Where a significant difference was noted, Tukey HSD was used as a post-hoc test in order to determine which groups were (not) differing from each other with respect to mean yields of tomatoes. Categorical variables such as extension provision models and different levels of adoption of modern technology in farming were compared using chi square tests. The statistical outputs were presented as narratives, tables, charts and graphs. The threshold for significance in all statistical tests was set at $p < 0.05$.

Qualitative data from FGDs and KII were tape recorded and then transcribed manually in English. Thematic analysis, based on research objectives, was conducted on the transcriptions.

Data variables

Table 3.1 shows the variables that were considered in the study.

Table 3. 1 Data variables

Dependent variable	**Independent variables**	**Effect**
AESPs model	Tomato yields	Increase/decrease in yields
Agronomic Practices		
Adoption of modern practices		
Adoption of modern technologies		

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Background characteristics

4.1.1 Agricultural Extension Service Providers

The current research involved a total of twenty greenhouses in Samburu County served by five agricultural extension service providers, namely; Red Cross Society, Catholic Diocese of Maralal, World Vision, Farm Africa and Ministry of Agriculture. All the greenhouses were of the same size, that is, 120 m^2 (8 metres by 15 metres) which is the smallest unit offered by the greenhouse construction company, Amiran Kenya. The AESPs represented the three models in provision of extension service; private, public and public-private-partnership (PPP). CDM and WV utilized their own agronomists in providing agricultural extension services to greenhouse tomato farmers. Farm Africa and Red Cross Society had no agronomist of their own and partnered with the public/MoA agronomists for extension services thus PPP (Table 4.1). The four greenhouses that were financed through the Constituency Development Fund (CDF) relied on MoA officials for extension services. Overall four greenhouses under public extension service provider were studied while in private and PPP extension service providers, eight greenhouses were investigated in each category.

Enquiries into the years of operation in the county revealed that CDM, Red Cross Society, WV and Farm Africa have been providing services for, respectively, twenty-six, four, fifteen and five years. The Ministry of Agriculture has been in operation since independence (1963) as shown in Table 4.1.

Table 4. 1 Selected attributes of the agricultural extension service providers

AESP	Years of Operation	Type	No. of agronomists
Ministry of Agriculture	Since independence (50 years)	Public	6
CDM	26	Private	1
Red Cross Society	4	PPP	0
World Vision	15	Private	1
Farm Africa	5	PPP	0

Source: Author's survey (2016)

4.1.2 Farmers

Each of the twenty study greenhouses was owned by a group of farmers. Overall, the twenty greenhouses belonged to a total of 708 farmers thus an average of about 35 farmers per group. The demographic characteristics of the farmers are outlined in the Table 4.2.

Table 4. 2 Profile of the greenhouse tomato farmers by three AESPs models

Characteristic	Type of extension service provider							
	Overall		Public		Private		PPP	
	No. (n=708)	%	No. (n=126)	%	No.(n=298)	%	No.(n=284)	%
Age								
<25	42	5.9	6	4.8	20	6.7	16	5.6
25-35	170	24.0	23	18.3	78	26.2	69	24.3
36-45	272	38.4	42	33.3	131	44.0	99	34.9
>45	224	31.6	55	43.7	69	23.2	100	35.2
Gender								
Male	331	46.8	79	62.7	150	50.3	134	47.2
Female	377	53.2	47	37.3	148	49.7	150	52.8
Marital status								
Married	583	82.3	77	61.1	240	80.5	266	93.7
Single/Widowed/Divorced	125	17.7	49	38.9	58	19.5	18	6.3

Source: Author's survey (2016)

The overall low prevalence of young people participating in the greenhouse tomato farming may be a reflection of the trend in Sub-Saharan Africa whereby young people have a low preference

for farming and getting them to work in agriculture remains a challenge (OXFAM, 2014). Female participation in greenhouse tomato farming was highest in the groups where extension service provision was of the PPP type (52.8%). This is in concordance with the findings by Ngugi, Muigai and Muhoro (2014) who on studying the KAPAP, which is a PPP project, reported that the model was associated with enhanced participation of women in all the PPP project activities.

4.2 Practices in greenhouse tomato farming

The current study endeavored to document the current practices in greenhouse tomato farming. The findings are outlined in Table 4.3.

Table 4. 3 Assessment of improved agricultural practices under the three AESPs models

Agronomic Practice	**Type of extension service provider**			
	Overall (n=20)	**Public (n=4)**	**Private (n=8)**	**PPP (n=8)**
Use of certified seeds/improved varieties	17(85%)	1	8	8
Recommended application of fertilizer	17(85%)	1	8	8
Planting at the optimum time (morning&/or evening)	20(100%)	4	8	8
Crop pests and diseases control	18(90%)	2	8	8
Optimum irrigation (amount, frequency & timing of watering)	17(85%)	1	8	8
Grading of tomatoes before marketing	13(65%)	0	6	7
Staking of plants	20(100%)	4	8	8

Source: Author's survey (2016)

Improved agricultural practices were generally well observed in greenhouses under private and PPP models. Indeed, of the seven agronomic practices under review, only one (grading of tomatoes before marketing) failed to attain full compliance among sixteen greenhouse tomato farming classified under the two models (Table 4.3). One unit under private model and two units under PPP model had failed to grade tomatoes before marketing at least once in the season

preceding the study season while all units under public had not graded their products prior to marketing at least once in the season studied. All the units had embraced the practice of planting at the ideal time (morning&/or evening) as well as that of staking of plants (Table 4.3).

Generally, agricultural practices in greenhouses under PPP mirrored those of greenhouses under private extension service providers. Utilization of improved agricultural practices was lowest in public greenhouses showing that PPP approach resulted in an improvement. This aspect was also noted by Kavoi, Mwangi and Kamau, (2013). The research team recounted that initiatives that embraced the PPP approach promoted the diffusion and adoption of improved technologies and innovations and, hence, improved and sustainable farm productivity. In a study done in Bihar and India similar observations were made with Singh (2008) perceiving the PPP model as one that encouraged sustainable and eco-friendly, agricultural practices and technologies. These included integrated management of pests and nutrients, water conservation practices and organic farming.

4.3 Assessment of yields

Table 4.4 presents the description of the greenhouse tomato yields (kg) for the units under different AESPs for season preceding the survey.

Table 4. 4 Description of the twenty greenhouses tomato yields (Kgs) by the AESPs

AESPs	N	Total	Mean	Std. dev	Std error	95% Confidence Interval		Min	Max
						Lower	Upper		
Catholic Diocese of Maralal	4	7809	1952.3	295.0	147.5	1482.8	2421.7	1724	2380
World Vision	4	7464	1866.0	119.6	59.8	1675.6	2056.4	1759	2030
Farm Africa	4	7350	1837.5	253.7	126.9	1433.8	2241.3	1574	2181
Red Cross Society	4	7705	1926.3	343.3	171.7	1379.9	2472.6	1688	2436
Ministry of Agriculture	4	3145	786.3	180.6	90.3	498.9	1073.6	581	976
Total	20	33473	1673.7	508.9	113.8	1435.5	1911.8	581	2436

Source: Author's survey (2016)

In total, 33.473 tonnes of tomatoes were harvested in the twenty greenhouse units in the season under inquiry thus an average (standard error (se)) of 1.67 (0.11) tonnes of tomatoes per unit. Greenhouses managed by CDM had the highest yields (7.81 tonnes) followed by those of the Red Cross Society (7.71 tonnes) and WV (7.46 tonnes). Greenhouses that were under Ministry of Agriculture initiative had the lowest total yields (3.15 tonnes) in the season appraised by the present research. The unit that produced the overall maximum yield (2.44 tonnes) was funded by the Red Cross Society while the one that recorded the overall minimum yield (0.58 tonnes) was under MOA. Noteworthy, is that the highest tomatoes' yield in the units initiated by MOA was far much below the lowest yields recorded in the units managed by the other organizations (Table 4.4).

The mean yields per greenhouse unit by the corresponding organization are shown in Figure 4.4. The mean±se yields per unit managed by the CDM, Red Cross Society and WV were 1952.3±147.5 kg, 1926.3±171.7 kg and1866.0±59.8 kg respectively. The mean±se yields per Ministry of Agriculture greenhouse unit was 786.3±90.3 kg.

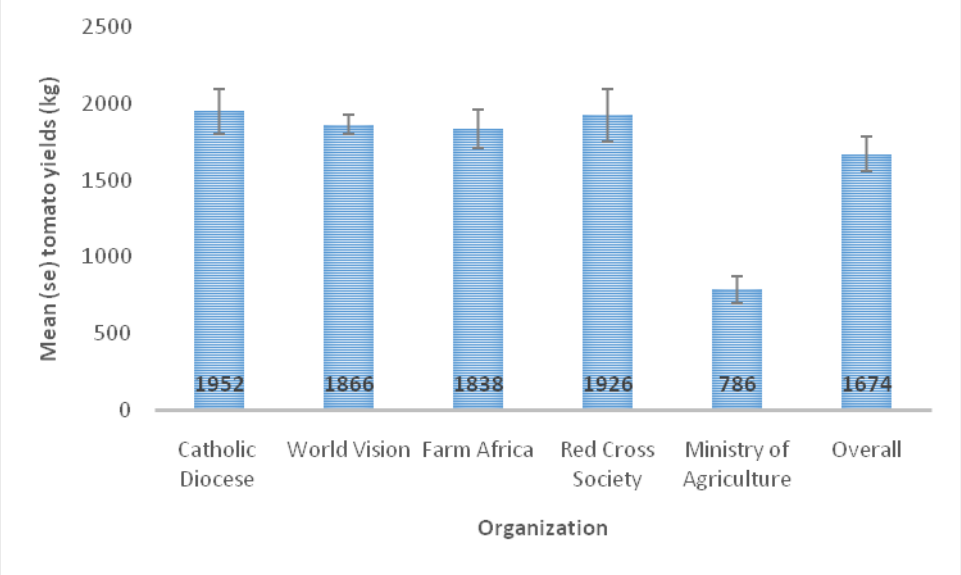

Figure 4. 1 Greenhouse tomato yields by agricultural extension service provider

4.4 Analysis of variance in tomato yields

Table 4. 5 represent the analysis of variance in tomato yields by the agricultural extension service providers.

Table 4. 5 Analysis of Variance in tomato yields

Source	Sum of Squares (SS)	df	Mean Square(MS)	F-value	P-value
Between Groups	3970995.3	4	992748.8	15.70	<0.001
Within Groups	948707.3	15	63247.2		
Total	4919702.6	19			

Source: Author's survey (2016)

The analysis showed that the mean yields varied in a statistically significant manner in at least two of the organizations ($F_{4, 19} = 15.696$, $p<0.001$). Multiple comparisons based on Tukey HSD as a post-hoc test was also conducted as presented in Table 4. 6.

Table 4. 6 Analysis of Variance in tomato yields

(I) Name of AESPs	(J) Name of AESPs	Mean Difference (I-J)	Standard error	P-value	95% Confidence Interval	
					Lower	Upper
Catholic Diocese of Maralal	World Vision	86.250	177.830	.988	-462.88	635.38
	Farm Africa	114.750	177.830	.965	-434.38	663.88
	Red Cross Society	26.000	177.830	1.000	-523.13	575.13
	Ministry of Agriculture	1166.000*	177.830	.000	616.87	1715.13
World Vision	Catholic Diocese of Maralal	-86.250	177.830	.988	-635.38	462.88
	Farm Africa	28.500	177.830	1.000	-520.63	577.63
	Red Cross Society	-60.250	177.830	.997	-609.38	488.88
	Ministry of Agriculture	1079.750*	177.830	.000	530.62	1628.88
Farm Africa	Catholic Diocese of Maralal	-114.750	177.830	.965	-663.88	434.38
	World Vision	-28.500	177.830	1.000	-577.63	520.63
	Red Cross Society	-88.750	177.830	.986	-637.88	460.38
	Ministry of Agriculture	1051.250*	177.830	.000	502.12	1600.38
Red Cross Society	Catholic Diocese of Maralal	-26.000	177.830	1.000	-575.13	523.13
	World Vision	60.250	177.830	.997	-488.88	609.38
	Farm Africa	88.750	177.830	.986	-460.38	637.88
	Ministry of Agriculture	1140.000*	177.830	.000	590.87	1689.13
Ministry of Agriculture	Catholic Diocese of Maralal	-1166.000*	177.830	.000	-1715.13	-616.87
	World Vision	-1079.750*	177.830	.000	-1628.88	-530.62
	Farm Africa	-1051.250*	177.830	.000	-1600.38	-502.12
	Red Cross Society	-1140.000*	177.830	.000	-1689.13	-590.87

Source: Author's survey (2016)

The comparison showed that MOA greenhouses had statistically significantly lower yields per unit as compared to the mean yields of units from other organizations ($p<0.001$). In particular, mean tomato yields per greenhouse unit initiated by MOA were, on average, at least one tonne

less than those of the counterparts. Those units managed by Catholic Diocese of Maralal and Red Cross Society had mean difference (±se) in tomato yields of 1140.0±177.8 and 1166.0±177.8 kilograms, respectively as compared to the Ministry of Agriculture's greenhouses.

4.5 Analysis of tomato yields by agricultural extension service provision model

Analysis of greenhouse tomato yields by extension service provision model was also conducted and the results presented in table 4. 7

Table 4. 7 Comparison of the greenhouse tomato yields (kg) by type of AESPs

AESPs	N	Total	Mean	Standard deviation	Standard error	95% Confidence Interval	
						Lower	Upper
Public	4	3145	786.25	180.605	90.303	498.87	1073.63
Private	8	15273	1909.13	213.455	75.468	1730.67	2087.58
PPP	8	15055	1881.88	283.484	100.227	1644.88	2118.87
Overall	20	33473	1673.65	508.853	113.783	1435.50	1911.80

Source: Author's survey (2016)

The total tomato yields were 3.14, 15.06 and 15.27 tonnes, respectively, for public, PPP and private extension service provision models. The mean yields were 786.3±180.7, 1881.9±283.5 and 1909.1±213.5 kilograms corresponding to public, PPP and private extension service provision models respectively (Table 4.7). Analysis of this variance in greenhouse tomato yields by the model of extension service provision showed that at least one of the models had significantly different greenhouse tomato yields ($F_{2, 19} = 34.200$, $p<0.001$).

Comparative analysis of the greenhouse tomato yields by the three models of agricultural extension provision, on the other hand, showed that a statistically significant difference existed between mean yields of greenhouse units under private and public extension service providers with the latter producing less by an average of 1122.9 ±147.0 kilograms per unit ($p<0.001$).

Furthermore, mean tomato productivity of greenhouse units under public extension service provider was statistically significantly less when evaluated against those under PPP models of extension service provision by a mean of 1095.6±147.0 kilograms ($p<0.001$). Contrary to this, greenhouse units under private and PPP models of extension service provision were not statistically significantly different in tomato productivity as assessed by yields in the season preceding the survey ($p=0.972$) as shown in Table 4.8.

Table 4. 8 Multiple Comparisons of the greenhouse tomato yields (kg) by extension model

(I) AESPs_type	(J) AESPs_type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Public	Private	-1122.875*	146.980	.000	-1499.93	-745.82
	PPP	-1095.625*	146.980	.000	-1472.68	-718.57
Private	Public	1122.875*	146.980	.000	745.82	1499.93
	PPP	27.250	120.008	.972	-280.61	335.11
PPP	Public	1095.625*	146.980	.000	718.57	1472.68
	Private	-27.250	120.008	.972	-335.11	280.61

Source: Author's survey (2016)

The higher performance observed in the greenhouses under PPP extension service provision model corroborates findings from other studies to indicate that PPP model can promote sustainability of rural livelihoods even in resource poor settings. Indeed, a study in Eastern Kenya reported that the production of sorghum went up by 72%, while maize increased production by 84%. Poultry production increased by 72% following introduction of the innovative approach based on PPP model of agricultural extension (Ngugi, Muigai & Muhoro 2014). In India, Tyagi and Verma (2004) reported that introduction of a PPP model resulted in the area dedicated to planting of cereals (rice, maize wheat, etc) declining by 8 percentage points. Noteworthy was that, in spite of this development, yields improved and thus no substantial loss

in crop production of staple foods. This implies that the adoption and utilization of improved agricultural practices extended to crops other than the targeted ones.

There has been general consistency on the positivity of embracing PPP in agricultural extension services even amongst the various variants of this approach. For instance, Costa Rica has a system which is unique involving the state providing agricultural extension services vouchers to farmers. The vouchers are used for acquisition of agricultural extension services and advice from specialists in the private sector. The trend in services provision resulted in a demand driven extension services (Farrington, et al, 2002). All these point out to the fact that PPP model may be the panacea for the poor linkages and coordination that have been noted particularly in agricultural extension in the current devolved government system (Karembu, 2011).

The improved yields observed in PPP model may be attributed to increased adoption of modern agricultural practices and technologies. A survey done by Tegemeo Institute (2006) shows that, households which utilized hybrid seeds, in addition to applying fertilizer, reported the highest levels of crop productivities. According to the Tegemeo study households that reported using a combination of the prescribed fertilizer and maize seed of the hybrid variety registered that there was a growth in productivity of 291 per cent when assessed against farmers who did not engage in the technologies that stimulated increased productivity in the entire period. It was also notable that farmers using hybrid maize seeds without application of any fertilizer increased their production by 133 percent. The farmers who applied the recommended fertilizer on the non-hybrid varieties of maize seeds were found to have increased the yields by 88 percent. The research also concluded that services provided tended to be correlated with the uptake of productivity enhancing technologies in small scale farmers studied. This underscores the crucial role of PPP extension service provision and the need to strengthen it.

4.6 Adoption of modern practices and technologies

Adoption of selected modern farming practices and technologies in greenhouse tomato farming was assessed based on the farming activities conducted in the current season as well as the documentation of the farming activities for the season prior to the survey. The findings are presented in Table 4.9 and Table 4.10. Analysis based on the use on certified seeds in the current season and the one preceding the survey showed that all the greenhouses under PPP and private extension service providers had utilized certified tomato seeds while only one group under public extension service provider had consistently used certified seeds.

Table 4. 9 Evaluation of adoption of modern practices and technologies

Practice	**Status**	**AESPs type**			***Chi-Square statistic (χ^2), degrees of freedom (df), P-value***
		Public	**Private**	**PPP**	
Certified seeds	Yes	1(25%)	8(100%)	8(100%)	*χ^2=14.118, df=2, p=0.001*
	No	3(75%)	0(0%)	0(0%)	
Recommended planting time	Yes	1(25%)	8(100%)	8(100%)	*χ^2=12.410,2,p=0.001*
	No	3(75%)	0(0%)	0(0%)	
Recommended pests/diseases control	Yes	1(25%)	8(100%)	8(100%)	χ^2=12.410, df=2, p=0.002
	No	3(75%)	0(0%)	0(0%)	
Optimum irrigation approaches	Yes	1(25%)	8(100%)	8(100%)	χ^2=12.410, df=2,p=0.002
	No	3(75%)	0(0%)	0(0%)	
Grading before marketing	Yes	0(0%)	8(100%)	8(100%)	*χ^2=20.016, df=2, p<0.001*
	No	4(100%)	0(0%)	0(0%)	
Staking of plants	Yes	4(100%)	8(100%)	8(100%)	_____
	No	0(0%)	0(0%)	0(0%)	
Application of inorganic [illegible]	Yes	1(25%)	8(100%)	7(87.5%)	*χ^2=9.844, df=2, p=0.007*
	No	3(75%)	0(0%)	1(12.5%)	

Source: Author's survey (2016)

This variation in utilization of certified seeds amongst greenhouses under different extension service providers was statistically significant (p=0.001). A similar pattern was observed amongst the greenhouse under various extension service providers with respect to abiding by the

scheduled/recommended planting time and adoption of recommended pests and diseases control practices and technologies ($p=0.002$). Only one out of the four greenhouses under public extension service providers was compliant with the optimum irrigation approaches while the rest of the greenhouses (under private and PPP) were able to maintain irrigation technologies and irrigation practices that were able to optimize productivity of greenhouse tomatoes ($p=0.002$).

All greenhouses graded their tomatoes before marketing but for all the groups which relied on the public extension service providers. This difference exhibited by the three extension service providers was statistically significant ($p<0.001$). In all the study greenhouses, staking of plants was practiced as required in tomato farming in greenhouses. A probe into the application of inorganic fertilizers based on a set of following criteria; recommended fertilizer type, optimum doses, appropriate mode and timing of application showed that greenhouses whose extension service provision arrangement were either private or PPP satisfactorily conformed with the guidelines and recommendations. On the contrary, only one greenhouse of the four under public extension service providers fulfilled the set of evaluation criteria (Table 4.9).

Further evaluation of the adoption of modern practices and technologies in greenhouse tomato farming showed that greenhouses under public extension service providers had statistically low adoption of water management and soil water improvement technologies when compared with their counterparts ($p=0.028$ and $p=0.039$ respectively), as presented in table 4.10. In all the greenhouses assessed, the practice of transplanting was satisfactorily observed including the prime time for transplanting (early morning and/or late evening).

Table 4. 10 Evaluation of adoption of modern practices and technologies

Practice	**Status**	**Extension service provider type**			***Chi-Square statistic, degrees of freedom, P-value***
		Public	**Private**	**PPP**	
Water management	Yes	1(25%)	5(62.5%)	8(100%)	χ^2=7.500, df=2, p=0.028
	No	3(75%)	3(75%)	0(0%)	
Soil water improvement	Yes	1(25%)	7(87.5%)	7(87.5%)	χ^2=6.667, df=2,p=0.039
	No	3(75%)	1(12.5%)	1(12.5%)	
Transplanting	Early morning/ Evening	4(100%)	8(100%)	8(100%)	_____
	Other	0(0%)	0(0%)	0(0%)	
Seeding	nursery	1(25%)	8(100%)	8(100%)	χ^2=14.118, df=2,p=0.004
	Nursery & others	3(75%)	0(0%)	0(0%)	
Foliar use	Yes	0(0%)	8(100%)	7(87.5%)	χ^2=15.333, df=2, p=0.001
	No	4(100%)	0(0%)	1(12.5%)	

Source: Author's survey (2016)

Assessment of seeding practices showed that greenhouses in which extension service provision was either private or PPP always planted the seeds in the nursery before transplanting in contrast with greenhouses under public extension service providers which sometimes deviated from this practice. Greenhouses under private extension service providers applied foliar fertilizers as, and when, required in contrast with greenhouses under public providers which reported erratic application of foliar fertilizers and in some cases missing to use the foliar fertilizer completely for a season. Further, one of the eight greenhouses under PPP system failed to apply foliar fertilizer at the suitable time at one point. The dissimilarities in compliance with utilization of foliar fertilizer between the three AESPs systems were statistically significant (p=0.001) as outlined in Table 4.10.

The enhanced adoption of modern practices and technologies under PPP model as compared to the Public model of extension service provision indicated that effective agricultural extension

programmes are key policy instruments used to foster agricultural productivity. This may be due to amelioration of information and knowledge transfer under PPP model. The two factors are considered important for accelerating agricultural development through appropriate production planning, adoption and realization of the full potential in agricultural activities (Pontius, et al, 2002).

4.7 Constraints to greenhouse tomato production

The present study sought to document the constraints faced by the farmers' groups with regard to greenhouse tomato production. The results were presented in table 4. 11

Table 4. 11 Constraints to greenhouse tomato production

No.	Constraint to production	Frequency (n=20)	%
1	Shortage of water for irrigation	8	40%
2	Pest and diseases	7	35%
3	Seeds (unavailability locally)	4	20%
4	Lack of market/fluctuating prices	4	20%
5	Lack of fertilizers	3	15%
6	Insecurity due to cattle rustling	3	15%
7	Lack of credit facilities	2	10%
8	High cost of inputs	2	10%

Source: Author's survey (2016)

Shortage of water for irrigation (40%) was the most frequently mentioned bottleneck to production by the key informants selected from the groups engaged in greenhouse tomato farming in the area. Seven key informants (35%) mentioned pests and diseases as a key constraint to greenhouse tomato production. In particular, three diseases were of concern to the greenhouse tomato farmers; early blight, powdery mildew and blossom end rot. On the other hand, white flies, cutworms and red spider mites were the key pests in greenhouse tomato farming in the study area. Unavailability of the recommended seeds locally and marketing challenges including high fluctuation of prices were each cited as constraints by 20% of the respondents. Insecurity due to cattle

rustling, unavailability of fertilizers locally, lack of credit facilities and high cost of inputs were other constraints reported by the respondents as presented in Table 4.11.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The current chapter summarises the results of the study. Additionally, it presents the conclusions and recommendations. Gaps that could be explored in further research studies are also suggested.

5. 2 Summary

The purpose of the study was to analyse the public-private-partnership in the provision of agricultural extension services with a bias to greenhouse tomato farmers in a remote rural area. The study laid emphasis on the enhanced productivity, adoption of modern farming practices and technologies as well as documentation of constraints to greenhouse tomato production. Three research objectives were formulated to guide the study. The first one sought to describe the characteristics of farmers under different agricultural extension service providers (private, public & p/p partnership). The second objective sought to compare the three models of provision of agricultural extension services with respect to efficiency of agricultural extension services, effectiveness in enhancing productivity and adoption of modern agricultural practices and technology in the greenhouse tomato farming. The last objective set to determine the challenges and constraints to greenhouse tomato production in the study area.

Based on each research objective, the findings revealed that:

(i) There was a general low participation of young people and women in the greenhouse tomato farming.

(ii) Most greenhouse tomato farmers generally applied good crop husbandry practices in their production such as soil fertility improvement, weed control, pests and disease control and training of the tomato crop. However, shortage of irrigation water, pests and diseases,

insecurity due to cattle rustling as well as poor road network served as major restraints to greenhouse tomato production and business.

(iii) The mean greenhouse tomato yields (kg) for the units under Public, PPP and Private extension service provision models for season preceding the survey were 786.3±180.7, 1881.9±283.5 and 1909.1±213.5 kilograms, respectively. Greenhouse units under private and PPP models of extension service provision were no statistically significantly different in tomato productivity. However, the units under public model consistently registered significantly lower yields when evaluated against those under the other models.

5.3 Conclusions

Tremendous benefits pertaining to poverty reduction could be gained by bringing the costs of production of the least efficient farmers to; at least, average levels of productivity. Realizing such gains call for comprehensive improvements in agricultural production efficiency which in turn depends on many factors. Efficient and focused provision of agricultural extension services is probably among the most important of these factors. Public resources for extension of agricultural services are very constrained and, by extension, inefficient. There is thus the need to explore a better model of extension service provision. Private extension systems may not be the best alternative especially where small and poor farmers in remote areas are involved. In fact, fears are rife that eventual privatization of extension services may not offer the solution to the current agricultural challenges, and principally where reaching smallholder farmers who inherently have limited resources are concerned. The government's role, which apart from funding, ensures oversight, quality assurance and provision of capacity building and information is needed and cannot be transferred to the private sector. Moreover, there is an accumulating weight of evidence supporting the notion that the engagement of private agricultural extension

services is not a substitute for extension services offered by the state to the public sector. In light of this, there is need to advocate for pluralism in agricultural extension by involving all key stakeholders, organizations and institutions. The PPPs model seems to offer a good solution to the challenges facing the current extension service provision approaches. The PPP model is just as efficient as the private model in the promoting improvement and adoption of modern agricultural practices. The yields are also comparable in the two models.

5.4 Recommendations

Based on the key evidence generated by the present study, the researcher recommends that:-

A feasibility study should be carried out before investing in greenhouses in Samburu County. This will provide guidance regarding the suitable location of the greenhouses where irrigation water, market, and chemicals to control pests and diseases are all accessible.

Sharing of information on greenhouse tomato production should be enhanced between and among the extension service providers and agricultural development partners in the county. This will reduce concentration of greenhouses on same areas by different donors.

A legal framework should be established to guide the formation of a well structured partnership between and among the public and private extension service providers in Samburu County as illustrated in Appendix IV. This will help remove the mistrust and lack of responsibility that currently exists.

Value addition for tomatoes should be done to solve the marketing problem and spoilage of tomatoes. This in return will improve the economic status and livelihoods of the farmers living in rural areas which are remote and facing constraints in terms of resources.

5.5 Suggestions for further study

By taking into account the findings of the study, the researcher highly recommends that a study should be carried out to find out how the tomato value chain can be improved in Samburu county. There is a need to explore the possibility of incorporation of ICT models in the PPP model of agricultural services extension in light of the increased penetration of mobile phones in the rural areas.

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APPENDIX I: LETTER OF INTRODUCTION

My name is Patrick Njeru, a Master of Science student in Agricultural Resource Management at the University of Nairobi. I also work in Samburu County as an Agricultural Officer. I intend to carry out an academic study on the analysis of public private partnerships in the provision of Agricultural Extension Services to Greenhouse tomato Farmers in Samburu. This is therefore to request you kindly to fill this questionnaire to enable me to collect data for my study. The data collected are purely for educational purposes and the information you give will be highly confidential. The outcome of the study will be availed to you on request.

Thank you and May God bless you.

Name: Patrick Ndwiga Njeru,

Tel.: +254 720 301 565

Email: njerupn@gmail.com

APPENDIX II: FARMER'S QUESTIONNAIRE

Study Title: *Analysis of PPPs in provision of agricultural extension services to greenhouse farmers in Samburu County, Kenya*

Section A. General Information

Name of the farmer's group: …….....

Number of Members: ……

Size of Greenhouse: 1. □ 120 m^2 (8 metres by 15 metres) 2. □ Other. Specify ……

Main Financier/Funding agency: 1. □ Government/Constituency Development Fund 2. □ Catholic Diocese of Maralal 3. □ Red Cross Society 4. □ World Vision 5. □ Farm Africa

Provider of agricultural extension services (*Tick all that apply*) 1. □ Government/Ministry of Agriculture 2. □ Catholic Diocese of Maralal 3. □ Red Cross Society 4. □ World Vision 5. □ Farm Africa 6. □ Other. Specify ……

Duration of engagement in greenhouse tomato farming ….. years.

Last season: Date of planting …./../….
Date of harvesting: First harvest …./../…. Last harvest …./../….
Total yield in the last season …… kilogrammes.

Section B. Profile of the Group Members

Table 1. Details of members of the greenhouse tomato farming group

No.	**Age** [years]	**Gender** [1=Male; 2=Female]	**Marital status** [1=Married; 2=Single; 3=Widowed; 4=Divorced]	**No.**	**Age** [years]	**Gender** [1=Male; 2=Female]	**Marital status** [1=Married; 2=Single; 3=Widowed; 4=Divorced]
1				16			
2				17			
3				18			
4				19			
5				20			
6				21			
7				22			
8				23			
9				24			
10				25			
11				26			
12				27			
13				28			
14				29			
15				30			

Section C. Profiles of the Providers of Agricultural Extension Services

Table 2. Background information of the providers of agricultural extension services

No.	Organization	Years of operation in the area	Number of agronomists
1			
2			
3			
4			
5			
6			
7			

Section D. Assessment of improved agricultural practices

Variety of tomatoes being grown 1. □ Anna F1 2. □ Tylka F1 3. □ Other. Specify .....

Measures employed to improve the soil fertility 1. □ Inorganic fertilizer 2. □ Farmyard manure 3. □ Crop rotation 4. □ Compost 5. □ Other (specify) .....

Application of inorganic fertilizer (*please fill the table below*)

Type	Rate	Time Of Application	Method of application
CAN			
DAP			
Urea			
Foliar			
Others (specify)			

Management practices employed in management of pests and diseases (*Tick all that apply*) 1. □ Pesticide use 2. □ Biological control 3. □ Rotation 5. □ Other. Specify .....

Details of pesticides applied in the last season

No.	Name of Pesticide	Time of application
1		
2		
3		
4		
5		

Staking of plants 1. □ Yes 2. □ No

APPENDIX III: KEY INFORMANT INTERVIEW GUIDE

Representative of the tomato farmers' group

Study Title: *Analysis of PPPs in provision of agricultural extension services to greenhouse farmers in Samburu County, Kenya*

Section A

Name …….. ……

Age: …. years

Gender 1. Male 2. Female

Farmers' group: …….....

Section B

Describe how you conduct tomato farming in your group? (*Enquire about seeds used; Seeding approach (nursery or else); soil improvement practices planting time; pests and diseases control; irrigation practices; staking; grading before marketing etc*)

What constraints does your group face with respect to greenhouse tomato production?

Ever heard of public private partnership? Explain

Has your group benefited from such a partnership? Please explain how?

What can you say about the potential of such partnerships in enhancing tomato production in this area?

APPENDIX III: KEY INFORMANT INTERVIEW GUIDE

Representative of the agricultural extension service provider

Study Title: *Analysis of PPPs in provision of agricultural extension services to greenhouse farmers in Samburu County, Kenya*

Section A

Name …….. ……

Age: …. years

Gender 1. Male 2. Female

Name of the organization ……..

Farmers' group supported: …….....**.....**

Section B

Describe your experience in the agricultural extension services to tomato farmers in this area?

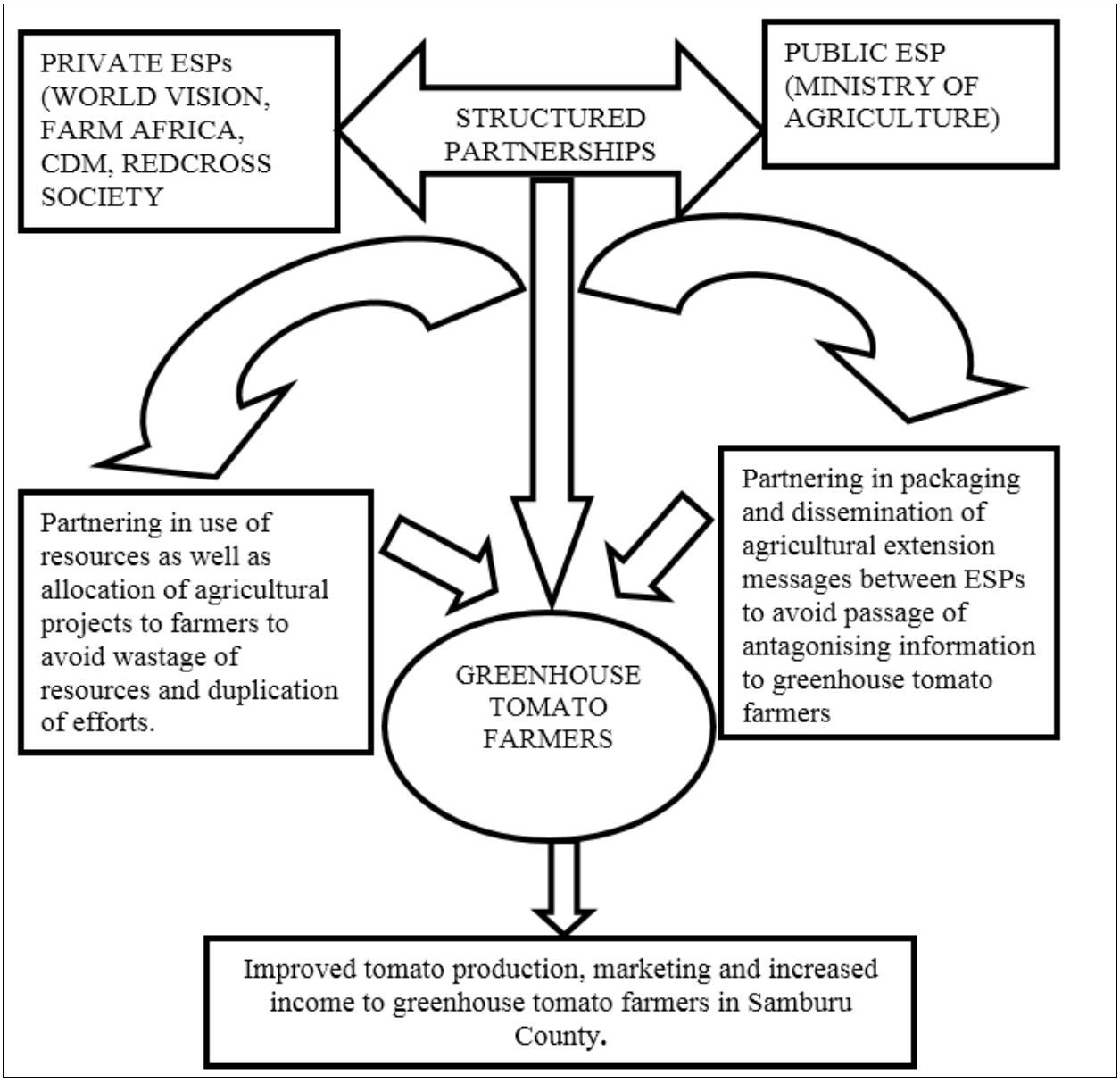
What challenges do the greenhouse tomato farmers in this area face?

What is your view of public private partnership in the provision of agricultural extension services to tomato farmers in this area?

Other comments.....

.....

APPENDIX IV: PROPOSED PARTNERSHIP STRUCTURE



The framework utilized in the current survey area is based on the premise that well-structured partnerships, that are perhaps legally binding, between the AESPs will ensure teamwork amongst them. This will be in matters relating to the purchase and location of the greenhouses, as well as in packaging and dissemination of extension messages regarding production, marketing and value addition of tomatoes. This in return will help avoid some of the challenges that the greenhouse tomato farmers face such as shortage of irrigation water, insecurity and marketing. This will then translate to higher yields that will earn the farmers more income and improve their livelihoods.