Effect of Certified Organic Production Systems on the Livelihood of Smallholder Farmers in Kenya

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DECLARATION AND RECOMMENDATION

DECLARATION

I hereby declare that this is my original work and has not been presented for award of any degree in Egerton University or any other University.

Signature__________________ Date____________________

Oscar Ingasia Ayuya
KD15/0371/12

RECOMMENDATION

This work has been prepared and presented to graduate school for examination with our approval as university supervisors.

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DEDICATION

I dedicate this work to my wife, Purity, and daughter, Getrude, for their encouragement, patience and push for tenacity that was discernible throughout the study period. It is also dedicated to my parents Mr. and Mrs. Ayuya, for their indelible providence and scintillating role in my life and my siblings, Hildah, Hillary, Sheillah and Laurah for their unconditional candid support.

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ABSTRACT

The main objective of the study was to assess the effect of certified organic production systems on the livelihood of smallholder producers in Kenya. The study followed explanatory research design using two purposively pro-poor chosen case studies (honey production in Mwingi district and vegetables production in Ngong district). Collection of primary data was through face-to-face interviews using pre-tested semi-structured questionnaire. Collection of contextual data was through focus group discussions. Poverty and women empowerment was measured using multidimensional methodology while nutritional security by means of household dietary diversity index. Data was analyzed by descriptive statistics, heterogeneous treatment effect model, endogenous switching regression as well as univariate and multivariate and two-Limit Tobit. Findings were that the economically and socially advantaged farmers benefited most in certified organic vegetable production systems, in terms of household income, while the opposite was true in certified organic honey production system. Certified organic producers were 7% and 18 % less likely to be poor compared to non-participating among vegetable and honey producers, respectively. On average, women involvement in agricultural decision making was about 38% and 35% in vegetable and honey producing households, respectively. Households who were not certified would have reported about 24% and 31% more HDDS among vegetable and honey producers respectively if they participated in certified organic production. To public policy, enhancing pro-poor participation in such emerging high value supply chains requires proper targeting and screening of famers during enrolment as well as enhancing other drivers that increase the likelihood of participation like training programs and building higher social capital. In terms of women empowerment, participation in off-farm income activities by women could prove essential in enhancing their empowerment in agriculture raising a concern to policy makers on how to create more sustainable off-farm activities opportunities for women to induce their empowerment further. Additionally, promotion of integrated economic, environmental and nutritional behavioural change farmer extension programmes through certified organic production systems schemes proves imperative among smallholder farmers in making informed food choices resulting to better household nutritional outcomes. Future research based on repeated surveys would be required to look into long-term impact of participation in certified organic production in smallholder production systems.

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LIST OF ABBREVIATIONS AND ACRONYMS

ASDS	Agricultural Sectoral Development Strategy
ATT	Average Treatment effect on the Treated
ATU	Average Treatment effect on the Untreated
BH	Base Heterogeneity
CAADP	Comprehensive African Agricultural Development Programme
CSHEP	Community Sustainable Agriculture and Healthy Environmental Program
DfID	Department for International Development
DHS	Demographic and Health Survey
EAOPS	East African Organic Products Standard
FAO	Food and Agriculture Organization
G.o.K	Government of Kenya
GHGs	Green House Gases
HDDS	Household Dietary Diversity Score
ICIPE	International Centre of Insect Physiology and Ecology
IFAD	International Fund for Agricultural Development
IFOAM	International Federation of Organic Agricultural Movements
IFPRI	International Food Policy Research Institute
KOAN	Kenya Organic Agriculture Network
KOFA	Kenya Organic Farmers Association
KOPA	Kenya Organic Producers Association
KTBH	Kenya Top Bar Hive
MDGs	Millennium Development Goals
NGOs	Non-governmental Organizations
OPHI	Oxford Poverty and Human Development Initiative
OFRF	Organic Farming Research Foundation
PRSP	Poverty Reduction Strategy Paper
TH	Transitional Heterogeneity
TU	Treatment on the Untreated
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
WEIA	Women's Empowerment in Agriculture
WHO	World Health Organization

CHAPTER ONE: INTRODUCTION

1.1 Background information

In the past decade, there has been growing demand for organic products, making organic agricultural production boom on a global scale (Willer and Kilcher, 2012; Sutherland, 2013; Denver and Jensen; 2014). Organic agriculture follows a system-oriented approach with an overarching principle of sustainable agricultural intensification. It involves exploitation of locally available inputs and ecological processes together with adoption of technologies such as closed nutrient cycles, management of soil fertility, pest and disease control through management and natural enemies and having minimal levels of pollution during postharvest handling (Setboonsarng, 2006; IFOAM, 2009; Bennett and Franzel, 2013; Forster *et al*., 2013). However, most production systems in Africa are still traditional and they are regarded as "organic by default" because of minimal or no usage of external inputs (UNCTAD, 2008; Weber, 2011). Organic agriculture is thus an environmentally friendly and sustainable production system that yields a multitude of economic, social, cultural, health and environmental benefits to producers and consumers (Asfaw *et al*., 2010; Barham and Weber, 2012).

Some specific potential benefits from organic farming include; higher income resulting from increasing demand and premium prices of certified organic products (Oberholtzer *et al*., 2012; Forster *et al*., 2013) and poverty reduction (Maertens and Swinnen, 2009; Bennett and Franzel, 2013). It also improves biodiversity, minimizes soil erosion and enhances soil fertility (Power and Stout, 2011; Kuhn *et al*., 2012; Power *et al*., 2013). Consumers believe that organic products taste better, they are more fresh and healthier than products produced under conventional systems (Wier and Calverley, 2002), which has changed marketing strategies towards promotion of food attributes.

In contrast, critics argue that organic farming is associated with low yields particularly during transition period, high production risks and low labour productivity compared to conventional farming as well as high costs of certification (Prasad, 2005; Beuchelt and Zeller, 2011; de Ponti *et al.*, 2012; Makita, 2012). Further, food standards have been associated with marginalization of poor farmers leading to greater inequalities. This is because of high costs involved, greater risks, weak managerial skills and inadequate capital reserves, which hinders their participation in the propitious high value markets (Reardon and Farina, 2002).

World organic production is fast growing due to increasing demand in export market by consumers concerned with healthy wellbeing and other credence attributes such as environmental sustainability (Willer and Kilcher, 2012; Denver and Jensen; 2014). There are also reports of increasing demand for organic products in developing countries (Willer and Kilcher, 2012; Probst *et al*., 2012). Consumer’s preference for organic products is revealed by way of their willingness to pay premium price the products. In light of the growing demand, organic proponents have come up with organic standards and certification to protect farmers, traders and consumers aimed at validating organic production practices and building confidence in market places (Janssen and Hamm, 2012; Costanigro *et al.*, 2014).

Currently, 37 million hectares (which accounts for 0.9 percent) of agricultural land has been converted to organic agriculture worldwide (Figure 1). A third of the world’s organic agricultural land (12.5 million hectares) is in developing countries and emerging markets accounts for over 80 percent of the world organic producers. Worldwide organic products sales in 2010 were 59 billion US dollars, which is more than three-fold increase in market expansion from sales of 17.9 billion US dollars in the year 2000. The increasing demand for certified organic products in American and European countries has led to growing disparity between production and consumption (Willer and Kilcher, 2012).

In Africa, certified organic agricultural land stands at slightly over one million hectares, which is three percent of global organic agricultural land involving about 540,000 organic producers in 2010. Uganda (with 0.23 million hectares), Tunisia (with 0.18 million hectares) and Ethiopia (with 0.14 million hectares) are the major producers of organic produce in Africa. The bulk of certified organic products in Africa are for export markets particularly in the European Union. Growth of organic agriculture in Africa is getting a nod among policy makers because of its momentous role it can play in improving the livelihood in resource constraint farming systems. Most notable was the decision in 2011 by the African Union to recognize potential of organic agriculture through initiatives and policies such as African Ecological Organic Agriculture Initiative (IFOAM, 2011; Willer and Kilcher, 2012).

In East Africa, there has been development of East Africa organic product standards by East Africa Community in 2007, which is a step in recognizing the potential of organic agriculture in the region by policy makers. Certified organic products in East Africa include; cash crops, fruits, nuts, fresh vegetable, animal products, herbs and spices. Donors, Non-Governmental Organizations (NGOs) and organic agriculture activists are involved greatly in promoting certified organic production for export and local markets in developing countries, Kenya included. This is mostly carried out in groups consisting of smallholder producers as a pro-poor strategy to improve their livelihood (Tumushabe *et al.*, 2006; Bouagnimbeck, 2009; Kledal *et al.*, 2009; Willer and Kilcher, 2012).

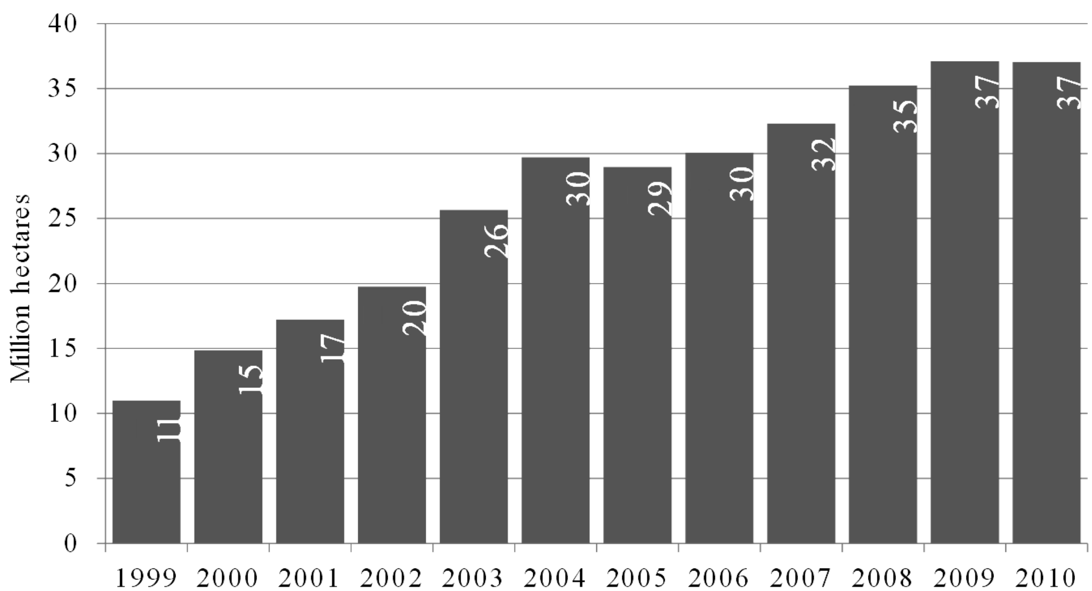

Figure 1: Global growth of the organic agricultural land 1999-2010
Source: (Willer and Kilcher, 2012).

Kenya organic production is fast growing but relatively small involving 30,000 farmers. Land under organic production in Kenya is over 182,000 hectares accounting for 0.69 percent of total agricultural area (Willer and Yussefi, 2006). There are four main certifiers of organic products in Kenya; EcoCert International, the Soil Association, AfriCert, BioSuisse and Institute for Marketecology (IMO). They are mainly involved in certifying organic vegetables and fruits, dried herbs, honey products, cosmetic and pharmaceutical products (UNEP/UNCTAD, 2007; Willer and Kilcher, 2011). However, among smallholder farmers, the more established certified organic production and marketing systems are vegetable and honey production. There has been significant recognition of certified organic agricultural production by the policy makers in Kenya and they are in process of developing national organic policy. This is in light of its potential to provide the needed pathway for sustainable agricultural intensification resulting in improved income and livelihood in smallholder farming systems through access to domestic high end outlets and international markets.

1.2 Statement of the problem

Kenya is experiencing growth in local-market oriented certified organic production to meet the growing demand for organic products due to increasing urbanization and income. The unrelenting effort by donors, community based organizations, organic activists and other organic production stakeholders have accelerated the adoption process as a development pathway in resource constraint production systems. After adoption of organic production and marketing processes, the processes are certified based on farmers' fulfilment of set organic standards. Certification validates farmers' organic production practices and builds consumer confidence in the market place, which enables farmers to access high value markets. Consumers in these markets pay price premiums to farmers for organic products on the premise of them practicing sustainable agricultural production, hence commercializing their farming systems.

Participation in certified organic production by smallholder farmers is on anticipation that it yields multiplicative dividends at household level because of integration of different household livelihood improvement aspects in these schemes. These aspects may include higher household income, reduced poverty levels, higher level of women empowerment in agriculture and nutritional security. However, empirically, little is known on the on-farm effects of these emerging local-market oriented certified organic production schemes on smallholder livelihood in Kenya. The current context of proliferation of pro-poor local market certified organic production schemes in Kenya and the inadequate knowledge on the effect of certified organic production on smallholder farmers' livelihood forms the major argument for this explanatory study. Consequently, this study was geared towards filling these knowledge gaps by providing empirical evidence of the on-farm effects of pro-poor certified organic production on the livelihood of smallholder farmers using innovative analytical approaches. The study demonstrates so using data from peri-urban vegetable and rural honey production systems in Kenya.

1.3 Objectives

1.3.1 General objective

The general objective of the study was to evaluate the on-farm effect of certified organic production on the livelihood of smallholder farmers in order to recommend relevant policies geared towards enhancing the effectiveness of certified organic production schemes in achieving improved livelihood outcomes in Kenya.

1.3.2 Specific objectives

1. To characterize and compare the socio-economic and institutional support characteristics of noncertified and certified organic smallholder producers in vegetable and honey production systems in Kenya.
2. To determine the effect of certified organic production on smallholder household income thereby identifying who benefits most from these schemes.
3. To determine the role of certified organic production on peri-urban and rural poverty reduction.
4. To assess the effect participation in certified organic production on the level of women empowerment in agriculture.
5. To determine the role of certified organic production on household nutritional status in smallholder production systems.

1.4 Hypothesis

1. Smallholder participation in certified organic production is not influenced by socioeconomic characteristics.
2. The effect of participation in certified organic production on total household income is not heterogeneous.

3. Certified organic production has no significant effect on poverty reduction.
4. Socioeconomic and institutional characteristics do not significantly influence the level of women empowerment in smallholder certified production systems.
5. In counterfactual case, noncertified producers would not significantly benefit, in terms of household dietary diversity, from certified organic production.

1.5 Justification of the study

Kenya's goal in environmental sector, as per Vision 2030 blue print, is to provide its citizens with clean, secure and sustainable environment by the year 2030 (G.o.K, 2010). One of the ways of achieving this is through extensive uptake of sustainable agricultural practices, such as organic agriculture. Adoption of certified organic farming could play an important role in achieving Millennium Development Goals; specifically goal number one of eradicating extreme poverty and hunger, goal number three of promoting gender equity and goal number seven of ensure environmental sustainability. This is on the premise that organic production systems incorporate different human developmental aspects geared towards improving the livelihood of resource constrained farmers. Proponents of certified organic production systems argue that it has the potential to offer new production and developmental pathway through market opportunities for smallholders. This is important in delivering farmers from traps of climate change effects, such as food and nutritional insecurity and poverty reduction in Africa, Kenya included (Willer and Kilcher, 2011).

Therefore, critical to these schemes is the potential to improve the livelihood of farmers. But it is not clear in empirical literature to what extent these schemes are improving smallholder farmer's livelihoods in Kenya. The study focuses on local-market-oriented production systems because of the current proliferation of such schemes in Kenya and other developing countries (Probst *et al*., 2012; IFOAM, 2013) and the recognition of certified organic production by policy makers in Kenya and other East African countries. On a wider scale, similar trend of expanding local production and consumption of organic products is also being experienced in other developing countries because of fast pace in urbanization and increasing income. Further, food safety issues, which certified organic farming addresses, is of major concern to the growing middle class that is associated with exposure of consumers and producers to a wide range of potential food safety risks including diseases resulting from poor food safety in developing countries is also a major concern among policy makers. This has made food safety to transform from just being a public health concern about a market development concern. Hence, it was important to assess existing certified organic production systems to determine their contribution to the livelihood of farmers in Kenya.

1.6 Scope and limitation of the study

The study was conducted in two case studies; the first case study was Mwingi district involving honey production and secondly; Ngong district involving vegetable production. Certified organic farmers were those who have continuously practiced certified organic production for at least three years. The study was anchored on socio-economics of organic farming with minimal evaluation of agronomics and animatics in the two case studies. In computing household dietary diversity score, the study did not consider seasonal variation, which may influence household food availability.

1.7 Definition of terms

Certified organic production: refers to the recognition by internationally certifiers of agricultural organic production systems of product that meet specific production and handling standards and regulations set by internationally accepted national or regional organic program.

Conventional agriculture: an agricultural production and marketing system characterized by usage of synthetic inputs.

Dietary diversity: the “number of different foods or food groups consumed over a given reference period” (Ruel, 2003).

Household: all persons living under the same roof and share meals.

Livelihood strategies: are choices that households make using their livelihood asset portfolio to meet certain objectives.

Livelihood: “it comprises the capabilities, assets (including both material and social resources) and activities required for a means of living” (Chambers and Conway, 1992).

“Kilimohai”: is a program under the International Federation of Organic Agricultural Movements (IFOAM) aimed at raising awareness and advocacy in East Africa to enhance the uptake organic farming.

Organic certification: is a system under which an internationally recognized independent party gives a written assertion that farmers’ production process conforms to certain organic standards.

Peri-urban area: refers to a transition or interaction zone, where urban and rural activities are juxtaposed, and landscape features are subject to rapid modifications, inducing by human activities (Douglas, 2006).

Smallholder: is a farmers who operate in less than ten acres of land (Ministry of Agriculture, 2010).

Social capital: “the resources to which individuals or groups have access through their social relationships” (Moore *et al*., 2009).

CHAPTER TWO: LITERATURE REVIEW

2.1 Definition and principles of organic agriculture

Various authors and organizations have defined organic agriculture in literature differently. According to UNCTAD (2006), organic agriculture is a production system that is sustainable and environmentally friendly that yields a wide range of economic, environmental, social and cultural benefits. The International Federation of Organic Agricultural Movements (IFOAM) defined organic agriculture as a production system designed at sustaining soil health, ecosystems and people. It relies on ecological processes, biodiversity and cycles that anchor well with the environment as opposed to using external inputs that have undesirable negative effects (IFOAM, 2009). On the other hand, FAO and WHO (2001) defined organic farming as a production management system that is concerned with healthy agro-ecosystem including biodiversity, biological cycles and soil biological activity. Among these definitions, this study adopted the IFOAM definition of organic agriculture, as it is more comprehensive.

World organic production is guided by four principles as stipulated by IFOAM, which includes principles of health, ecology, fairness and care. The principle of health affirms that organic agriculture should enhance ecosystem health including that of the smallest organisms in the soil to human beings from production, distribution and final consumption. The principle of ecology roots that organic agriculture enhances the accomplishment of ecological balance goal. This is through designing the farming systems properly, establishing and maintaining genetic and agricultural diversity. The principle of fairness is premised on the need that organic agriculture should develop association that ensures fairness to the environment and human beings. Emphasis is also on fair distribution of organic benefits on the part of economic agents involved in organic food chain and reinvestment in the natural environment. The last principle of care avows the call for governance of organic agriculture systems in a manner that is precautionary and responsible for the benefit of current and future generation wellbeing as well as that of the environment (IFOAM, 2009).

2.2 Benefits of organic production

Various studies have been conducted to identify the benefits of organic agriculture and have had mixed findings. In terms of productivity, Kilcher (2007) and Badgley *et al*. (2007) found out the organic farmers experience higher output on the same area that leads to enhanced food security, and reduced dependency on market for food. However, Kilcher (2007) and OFRF (Organic Farming Research Foundation) (2006) argue that farmers usually have low yield during the initial stages of conversion to organic agriculture. This is a result of pending re-establishment of soil microbes and nutrient cycling to start taking place before yields starts to increase significantly. This is due to time taken for soil organic matter and biological activities to take place and their establishment. Concurrently, Pretty *et al.* (2002) observed that organic farming increases yield, but in some developing countries. However, Greenthumb (2002) reports on the inability organic agriculture to sustain soil fertility. In contrast, Shirsagar (2008) studied the economics of organic sugarcane farming in Maharashtra, where yield of organic sugarcane was lower by 6.79 per cent than in conventional sugarcane farming. However, compensation of low yield was by premium price paid on organic sugarcane leading to 15.63 percent higher profits than conventional sugarcane farming.

Bolwig *et al*. (2009) found that farmers' participation in certified organic export production had significant higher income than their counterpart in conventional production. The higher income by organic producers was because of premium price paid on certified organic products, but side selling at conventional prices reduced their effect. Further, Byerlee and Alex (2005) found that an increase in crop yield by 10 percent leads to a drop in the number of income poor persons in sub-Saharan Africa region by 7.2 percent. Concomitantly, Foley (2006) notes that organic agriculture among smallholder farmers is a low cost technology since they do not use chemical inputs that are expensive and harmful to health, which translates into more profits.

Organic agriculture has also the potential of mitigating climate change because of low levels of fossil fuel-based inputs use than conventional production systems (Ziesemer, 2007; Bellarby *et al.*, 2008; Scialabba and Müller-Lindenlauf, 2010). Although agricultural production contributes significantly to emission of Green House Gases (GHGs), switching to organic agricultural practices could transform agriculture to a net carbon sink. Khor (2008) concluded that organic agriculture plays a crucial role in climate change mitigation by reducing Greenhouse gases emissions, increasing stabilization of soil organic matter and increasing the capacity of soil retaining water. Therefore, organic agriculture offer potential mitigative and adaptive strategy with prospects of cushioning farmers against risks associated with climate change.

Literature on effect of organic farming on women empowerment is very scanty. Willer and Yussefi (2006) notes that women involvement in organic agriculture increases their level of empowerment. A study by Blackden and Wodon (2006) demonstrated that when women have access to productive resources and if empowered to make decisions they tend to optimize their usage of farm resources thereby increasing crop diversity, which eventually leads to nutritional benefits. Nutritional diversity and adequacy due to crop species diversity is imperative in the fight against malnutrition and management of diseases in developing countries (Rosegrant *et al.*, 2005; Miller and Welch, 2013). However, such impacts has not received full-bodied empirical evidence particularly in developing countries, Kenya included, where women are mostly engaged in agricultural production and the country is still facing food and nutritional insecurity related problems.

Organic agriculture is also been linked with biodiversity and environmental conservation. It is argued that organic production systems has the prospects of supporting conservation of biodiversity through; increasing the variety of species on the farm, upholding healthy soils and its fauna, increasing energy efficiency, lowering global pollution and to larger extent increasing agro-biodiversity (Randerson, 2004; IFOAM, 2006). According to IFOAM (2008), organic farming enhances the maximization of environmental services through maintenance of biodiversity, which improves soil quality and shuns chemical inputs that taints ecosystems.

Adoption of organic agriculture reduces farmers' exposure to hazardous agricultural chemicals, thus yielding health benefits to farmers (Lyons and Burch, 2008). However, little systematic empirical evidence exists to link certified organic farming and biodiversity. Proponents of organic agriculture see it as a livelihood strategy that transforms rural farmers to achieve certain livelihood outcomes which includes reduced poverty level, improved food security and environmental conservation through access to high value markets (Bakewell-Stone, 2006; Lyons and Burch, 2008). Other potential benefits of organic agriculture are higher vitamin content and greater mineral variety and it minimizes soil erosion (Sustainable Enterprises, 2002), as well as it improves animal welfare (Holden, 2004).

Descending voices on the importance of organic agriculture are also there. Quinn and Sandy (2002) and Peters (2003) argue that organic agriculture requires huge volumes of manure, more management and intensive tillage. On the other hand, Giovanucci (2005) argue that high initial cost during organic transition as well as the high cost of certification and time taken in keeping and managing farm records in order to comply with organic standards proves to be an uphill task to many smallholder producers.

2.3 Women and their empowerment in agriculture

Critically, women have a pivotal part in advancing the development of the agriculture sector and ensuring food security. In Sub-Saharan Africa (SSA), women contribute more than 43 percent of the labour force in agriculture and three-quarters of food production. Women empowerment has proved important in development of agriculture in Africa, as the continent strives to fade of challenges posed by food insecurity and poverty (FAO, 2011). Studies have shown that women representation and integration of gender issues in development projects remains a big challenge in developing countries (Zuckerman, 2002; World Bank, 2009).

In Africa, women face myriad of challenges as they pursue multiple livelihood strategies. This constraint includes less holding of property rights on land, credit access, inability to get hired labour and inadequate access to extension contacts. Regardless of these constraints, women in Africa have shown potential of growth in agriculture and various studies have empirically shown that. For example, Katrine *et al.* (1994) showed that if women are accorded similar access to productive resources like that of men, crop yield would increase by approximately 20 percent. Christopher (1996) shared the same views, where distribution of fertilizer and labour equitable between women and men headed households led to increase in household productivity by six percent. Such increase in productivity resulting from women empowerment translates into more income that is beneficial to families as it improves children’s health and general household nutrition status (Esther, 2003).

Women disempowerment in developing countries, Kenya included, has led to underperformance of agricultural sector and any effort to revert the trend could prove fruitful in guaranteeing food and nutrition security, overcoming poverty and management of natural resource in farming systems. This is by intensifying access to and control over productive resources by women, which are vital in creating conducive environment for their empowerment (Farnworth and Hutchings, 2009). In organic production systems, it is eminent that very limited studies has been carried out in developing countries, Kenya included, evaluating its contribution to women empowerment (Farnworth and Hutchings, 2009; Oelofse *et al.*, 2010). Strands of literature reveal that some studies have concentrated in measuring women empowerment. Measurement of women empowerment has been through decision-making ability, relative physical mobility, political and leadership participation, security economically and freedom from domestic violence (Kandpal *et al.*, 2012).

Further, women empowerment is an unobservable latent variable and studies have innovatively used observed proxy characteristics as a measure of empowerment. Studies have found out that women participation in off-farm activities increases women bargaining power at the household level (Anderson and Baland, 2002), and women owning assets also contributes significantly to women empowerment in developing countries (Agarwal, 2001). Access to credit in rotating savings or microfinance institutions and social status of the woman has positive influence on women empowerment (Quisumbing and de la Briére, 2000; Anderson and Baland, 2002; Ngo and Wahhaj, 2012). Women with higher levels of education have higher probability of women being empowered (Rahman and Rao, 2004). However, such empirical evidences in Kenya are very limited and yet it is important to policy makers and program planners when designing and implementing agricultural developmental projects.

2.4 Poverty measurement and analysis in Kenya

In Kenya, the percentage of population below national poverty line stands at 46 % (World Bank, 2012). Poverty reduction has been a fundamental aspiration of policy concern in Kenya, leading to development of various strategies. The Kenyan government developed the Poverty Reduction Strategy Paper (PRSP) in 2001 in order to understand the potential causes and solutions to poverty (G.o.K, 2001). The PRSP delineated the priority areas and necessary measures for poverty reduction and economic growth. In 2003, the government of Kenya initiated new economic recovery process and poverty reduction initiatives by developing Economic Recovery Strategy for Wealth and Employment Creation (G.o.K, 2003). In 2008, the government launched Kenya Vision 2030, a long-term development plan that proposes multiple pro-poor investments strategies in agricultural, industrial and service sectors (G.o.K, 2007).

Kenya has also developed the Agricultural Sectoral Development Strategy (ASDS), which outlines the government’s investment strategy to increase productivity in agricultural sector by 10%. It has taken into consideration the continental initiative of Comprehensive

African Agricultural Development Programme (CAADP), which distinguishes agriculture's contribution to African countries economic growth and Millennium Development Goals (MDGs) that countries subscribed to reduce extreme hunger and poverty by 2015 (G.o.K, 2010). The governing goal of ASDS is to reduce unemployment and two major challenges of poverty and food security that Kenya continues to face.

There has been growing literature on poverty analysis and measurement in Kenya (Burke *et al.*, 2007; Batana, 2008; Mathenge and Tschirley, 2008; Suri *et al.*, 2008 Kabubo-Mariara *et al.*, 2010; Kiuri, 2010). Burke *et al*. (2007) investigated the movements in and out of poverty using an asset-based measure of poverty. Batana (2008), estimated multidimensional poverty in fourteen countries in SSA and found that lack of education was the main contributor of multidimensional poverty and prevalence of poverty was more on persons living in rural areas than those in urban areas. Mathenge and Tschirley (2008) studied growth of income and its mobility in rural households of Kenya with emphasis on the role of education on poverty reduction using panel data. Suri *et al*. (2008) used panel data to evaluate the relationship between rural incomes, inequality and poverty dynamics in Kenya using multinomial and Probit econometric models. Kabubo-Mariara *et al*. (2010) studied poverty comparisons by measuring poverty in multidimensional way but with emphasis on maternal and child well-being. The Kenya Demographic and Health survey data was used to generate poverty profiles during 1993 to 2003 using the asset base and health status dimensions and following the counting approach developed by Alkire and Foster (2010). Kiuri (2010) investigated the relationship between remittances and poverty using Heckman two stage and instrumental regression models.

From literature, it is prudent to note that poverty measurement has evolved from the traditional undimensional approach (using income and poverty lines or asset base) to innovative multidimensional approach. However, limited studies have evaluated poverty in multidimensional way, as most of the studies have primarily based their analysis on income, consumption or asset value using poverty lines. Concerning certified organic agriculture, limited studies exist on its role in reducing poverty.

2.5 Impact evaluation in agriculture

Impact evaluation is a vital tool in ensuring that programmes or interventions in agriculture meet their desired goals. Results of evaluation are essential to developmental planners and policy makers when designing or amending policies in view of optimizing intended outcomes. Care is important in impact/effect studies as they suffer from statistical problem of internal validity, leading to implausible results. Internal validity refers to the ability to affirm with certainty that the measured effects are true. Internal validity problem in analysis of impact of interventions are caused by selection biasness as result of self-selection in the intervention. Selection bias affects the outcome, contamination as the result of spillovers and problem of attrition and measurement errors common with impact evaluation. To solve the problem of attrition from the control group and measurement errors from the treated group is by not revealing to the respondents that the information they give is for the purposes of impact evaluation. The evaluator could just state that the information is for research purposes (Blundell and Costa Dias, 2000; Winters *et al.*, 2010).

Various methodologies to overcome such problems exist in literature and they fall into five major categories with each developing an alternative way of getting a counterfactual. The first method is pure random social experiment that compares the control and the treated groups, and the control is a randomized subset of the treated group. Experiments if correctly setup, they overcome the problem of missing data thus its preference. However, detractors of the methodology gives reasons of high costs to implement and non-acquiescent to extrapolation (Blundell and Costa Dias, 2000).

The second method is the 'difference-in-differences' approach, which is measured in two ways. First is to find the difference in the effect variable involving treated and control group before a programme and after, and then subtract the former from the latter. Secondly, is by determining the change in the value of effect variable before and after the programme for treated group and the change in values for the control group for the same period then subtract the latter from the former. This method overcomes the problem of self-selection but faces a problem of contamination in the sense that it is difficult to find pure control and treated groups (Blundell and Costa Dias, 2000).

The matching approach is the third method which is meant to surmount the effects of selection bias and that of missing data from the counterfactual (Blundell and Costa Dias, 2000; Wooldridge, 2002). This method involves the matching the control group and the treated group and the control group should have the same characteristics as the treated. The impact of the intervention is by way of finding the average treatment effect on the treated (ATT). This approach has gain popularity in impact evaluation recently and has been used in a various studies (Ali and Abdulai, 2010; Blackman, 2010; Rao and Qaim, 2011; Pierre *et al.*, 2012; Ruben and Fort, 2012).

The fourth method is by use of instrumental variable or quasi-experimental approach that solves the problem of endogenous explanatory variables (Kiuri, 2010; Shen *et al.*, 2009; Wooldridge, 2002). The instrumental variable method solves the econometric problem of selection bias in impact evaluation studies. The fifth method is that of switching regression models. This includes the Heckman two-stage model that controls for self-selection (Heckman, 1979). The other approach of switching regression is the endogenous switching regression model that takes into account of selection bias and the systematic differences that exists across group of evaluation (Maddala, 1983). Application of this model is evident in a number of studies in Kenya. Rao and Qaim (2011) used it to analyse the effect of supermarkets on household income and Owuor (2009) used it to determine the effect of group based credit on productivity among smallholder farmers in Kenya. However, it is important to highlight at this point that the choice of analysis technique is dependent on the data type and nature of the programme /intervention.

2.6 Overview of certified organic farming in Africa and Kenya

In Africa, certified organic agricultural land stands at more than one million hectares, which accounts for three percent of global agriculture land under organic agriculture involving 540, 000 producers of organic products in 2010. Major countries in Africa involved in organic farming are Uganda (230,000 hectares), Tunisia (180,000 hectares) and Ethiopia (140,000 hectares). The prime market for certified organic products is exports market, particularly in Europe, that is experiencing increasing demand for certified organic products. In SSA, organic agriculture revenue contribution was 42 million and 33.9 US dollars in 2010/2011 in Uganda and Ethiopia, respectively. Over the years, Africa has been experiencing significant growth in organic agriculture (Willer and Kilcher, 2012).

In Kenya, there are efforts by Non-Governmental Organizations (NGOs) and private sectors to promote organic certified production aimed at improving the livelihood of farmers among them food insecurity, women empowerment and poverty. It is also advocated as it enhances diversification of food production at the household level, ensures sustainability of the ecology in farming systems as well as increasing income of farmers through their participation in high value market (UNEP/UNCTAD, 2006; Willer and Kilcher, 2012). Large scale production has been taking place for the last two decades and the main crops are vegetables and fruits. However, smallholder production of organic products has taken shape, where farmers organize themselves in farmer groups and involves production of vegetables, fruits, essential oils, spices, honey, herbs, cosmetic and pharmaceutical products. A representative body of the smallholder farmers has been formed known as Kenya Organic Farmers Association (KOFA), while large-scale farmers formed the Kenya Organic Producers Association (KOPA). Further, KOPA and KOFA formed an umbrella body called Kenya Organic Agriculture Network (KOAN) to coordinate national organic agricultural activities in Kenya (UNEP/UNCTAD, 2006).

Lately, policy makers have embraced organic agriculture though there is no existence of any stand-alone official policy on organic agriculture in Kenya. This is evident by inclusion of organic production in the Food Security and the Soil Fertility Policy drafts. Currently, the Ministry of Agriculture has instituted an organic desk to aid in developing an organic policy as well as helping in mainstreaming of organic agriculture in other policies related to agriculture (Willer and Kilcher, 2010). This is a big step towards promotion of organic farming in Kenya. Concurrently, the regional organic standards, East African Organic Products Standard (EAOPS) commissioned in 2007, which works closely with the 'Kilimohai' brand to develop, promote and boost regional organic trade.

Certified organic production in Kenya involves internationally acknowledged certifying bodies. However, the mother certifier is IFOAM, which is responsible for formulation of essential organic standards. Large international organic certifiers accredit the small national certifiers that are responsible for certifying individual producers and conduct follow-ups by monitoring farmer activities. Transition from conventional farming requires two or three years, in that, the farmer would adopt the organic practices before certification. Compliance of the require standards is achieved through monitoring at least once per year. The process involves application by farmers individually and groups to be certified, then there would be inspection by the certifiers and based on the results of the inspection the certification decision is made and compliance form is drawn (Encert, 2007; Van der Vossen, 2005).

2.7 Theoretical and conceptual framework

2.7.1 Theoretical framework

The study is anchored on the expected utility maximization theory since farming households in developing countries, Kenya included, face uncertainty during production and multifaceted market imperfection. The framework postulates that decision makers make choices between uncertain and risky investments by weighing their expected values of their utility. This means that the weighted sums obtained by adding the utility values of outcomes multiplied by their respective probabilities (Davis *et al.*, 1997). The assumption is that farmers maximize expected utility according to a Von Neuman Morgenstern utility function defined over wealth (W). When faced with a choice between two optional practices, the i^{th} farmer compares the expected utility participation in certified organic production (oc), $EU_{oci}(W)$ to the expected utility with conventional farming (cf) $EU_{cfi}(W)$. While direct measurement of farmers' perceptions and risk attitudes on certified organic production are unobservable, inferences for variables that control distribution and expected utility evaluation of certified organic production system is made (Davis *et al.*, 1997). These variables are used as a vector 'X' of attributes of the choices made by farmer $\boldsymbol{i}$ and ε_i is a random disturbance that arises from unobserved variation in preferences, attributes of the alternatives, and errors in optimization. Given the usual discrete choice analysis and limiting the amount of non-linearity in the likelihood function, $EU_{oci}(W)$ and $EU_{cfi}(W)$ may be written as;

$$EU_{oci}(W) = \alpha_{oc} X_i + \varepsilon_{oci} \quad (1)$$

$$EU_{cfi}(W) = \alpha_{cf} X_i + \varepsilon_{cfi} \quad (2)$$

The expression of the difference in expected utility is;

$$EU_{oci}(W) - EU_{cfi}(W) = (\propto_{oc} X_i + \varepsilon_{oci}) - (\alpha_{cf} X_i + \varepsilon_{cfi})$$

$$= (\alpha_{oc} - \alpha_{cf}) X_i + (\varepsilon_{oci} - \varepsilon_{cfi}) \quad (3)$$

$$= \alpha X_i + \varepsilon_i$$

where $\alpha = (\alpha_{oc} \alpha_{cf})$ and $\varepsilon_i = \varepsilon_{oci} \varepsilon_{cfi}$.

A preference for the certified organic production systems revealed if;

$$EU_{oci}(W) - EU_{cfi}(W) > 0 \quad (4)$$

Whereas, a preference for the conventional farming revealed if;

$$EU_{oci}(W) - EU_{cfi}(W) < 0 \quad (5)$$

2.7.2 Conceptual framework

The was anchored on the sutsainable livelihood framework as developed by Department for International Development (DfID, 1999). It is an important framework in impact studies and involves the association of livelihood outcomes and germane of issues and factors at micro and macro levels. Further, it an important framework used in assessing and prioritizing interventions by developing relevant policies at household, community and national levels (Adato and Meinzen-Dick, 2002).

The study adapted this framework (Figure 2) to analyze the effect of organic certified production systems on livelihood of smallholder farmers in Kenya. Certified organic production was a shock/intervention aimed at commercializing smallholder agriculture resulting in livelihood improvement, known as livelihood outcomes. The household livelihood assets (human capital (H), natural capital (N), financial capital (F), physical capital (P) and social capital (S) influenced the adoption of certified organic production. Processes and structures also influenced the participation in certified organic production, which may include access to credit facilities, the laws and the institutions concerned with the intervention. Further, the vulnerability context in terms of shocks associated with their production systems like price risks might force the farmer to participate in certified organic production systems.

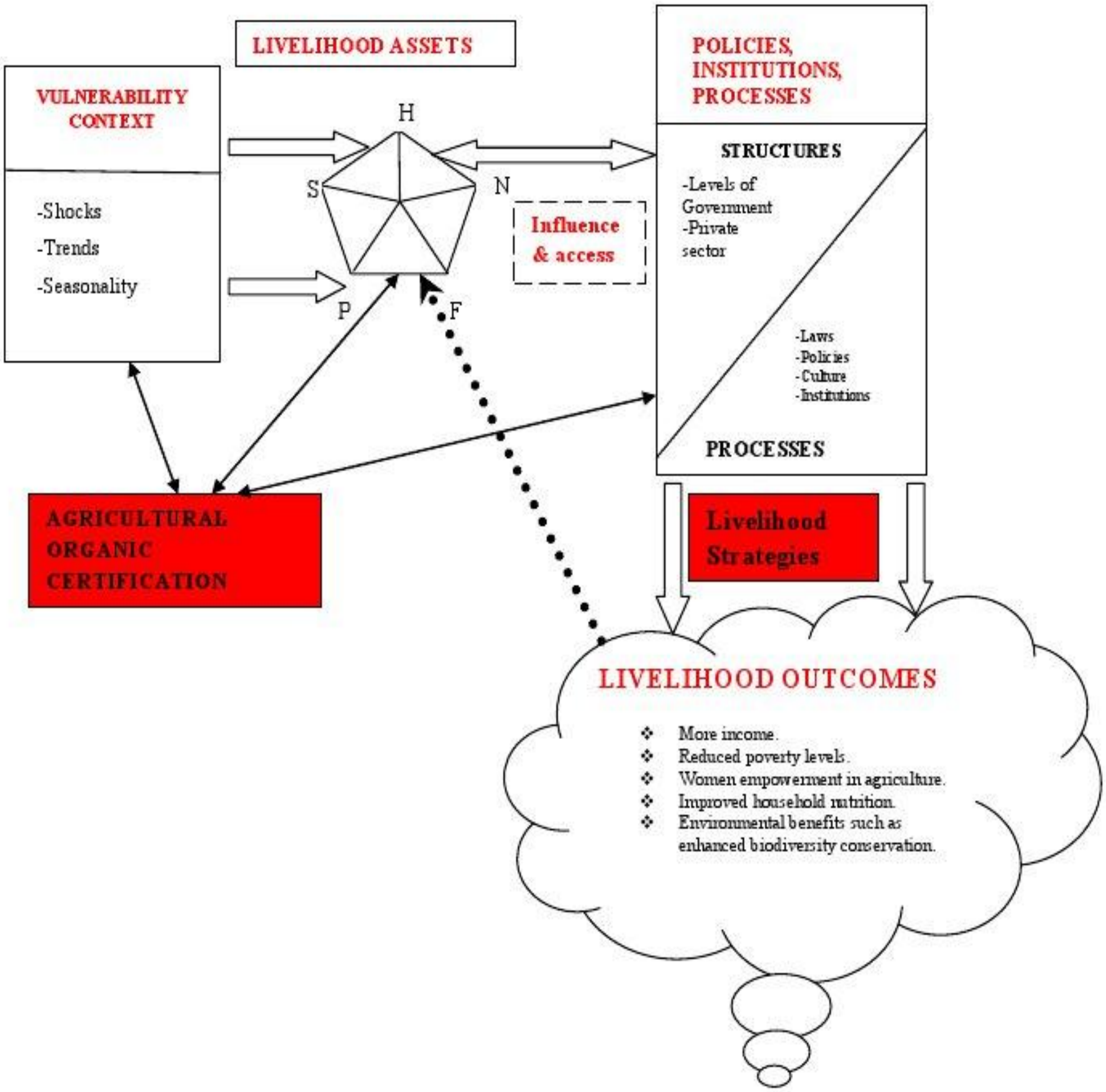

Figure 2: Conceptual framework
Source: Adapted from DfID (1999).

The premeditated management of livelihood asset collection by the household defined their livelihood strategy (that is participation in certified organic production or not). Livelihood strategies are choices that households make using their livelihood asset portfolio to meet certain objectives. Eventually, household participation in certified organic production schemes has potential outcomes, which indicates household well-being and potential growth in future. The main potential outcomes at household level include; improved income, nutritional security, women empowerment and eventually poverty reduction. However, Narayan *et al*. (2000) notes that farmers are concerned with their food and nutrition security, health condition, empowerment and self-esteem when participating in community initiatives. These livelihood outcomes in turn influence the status of household livelihood asset portfolio.

CHAPTER THREE: METHODOLOGY

3.1 Study area

The study used data from a cross-sectional survey in the months of June and July, 2013 in two case sites in Kenya; vegetables production in Ngong district on coordinates 1°21'34"South, 36°39'44"East and organic honey production in Mwingi district on coordinates 0° 56' 0" South, 38° 4' 0" East. The chosen case study sites met the following strict criteria for selection; (i) consist of smallholder producers some of whom are certified, (ii) the commodity has linkage to markets locally, (iii) there exist a relatively large number of certified organic and conventional producers in the case study site, (iv) at least have one animal and crop organic certified production system, (v) the production system is pro-poor and (vi) the organic certified and conventional producers are relatively homogeneous in terms of production systems and other socioeconomic characteristics, (vi) have relatively developed pro-poor crop and livestock organic production and marketing systems supplying local markets and (vii) have different program designs to assess potential effect of program design and targeting in achieving pro-poor objectives among smallholder farmers.

Ngong district is along the great rift valley near Ngong' hills, located southwest of Nairobi, the capital city of Kenya. The district receives bimodal rainfall pattern; short rains occurring between October and December and long rains between March and May. The soils are moderately fertile making the ecosystem fragile and easily degradable. Vegetable farming is a dominant crop cultivated because of its ready demand in the ever growing capital city in Nairobi. Farmers in the area are adopting organic farming systems due to promotion by developmental partners and the growing local consumer demand from middle and high income earners in Nairobi city. The change in consumer behaviour is partly attributed to uncontrolled intensive chemical usage in conventional vegetable production, which has negative health effects to consumers and producers.

The program was initiated by some already existing groups of farmers with assistance of Kenya Organic Agriculture Network (KOAN), a local non-governmental organization, in 2007 with objective of poverty alleviation, environmental conservation, women empowerment and improving household nutrition in participating households. Enrolment of new producers in the program is through formation and registering of new groups or joining already established groups. They also have to meet other criteria including a three year conversion period, which involves no use of synthetic inputs, and to implement organic practices in soil fertility management, conservation measures, and use of environmental friendly manure, weed, pest and disease management. Other basic requirements include the need for farmers to maintain buffer zones around their farms, use of organic seeds and not to use sludge from sewerage in vegetable production and other conventional substances. Encert Kenya is the certifier of organic production and marketing systems. The farmers supply their organic vegetables to hotels and restaurants, supermarkets, several organic shops and flea market in Nairobi.

Apart from the government extension service providers, Community Sustainable Agriculture and Healthy Environmental Program, a registered community based organization, are also involved in promotion and training of farmers on sustainable organic and bio-intensive vegetable production. Extension delivery system includes components of women empowerment by integrating women in agricultural production and marketing, agricultural trainings and leadership in farmer led organizations. Women are also facilitated to gain access in organic markets, which facilitates them to have start-up capital to finances their on-farm and off-farm investments. Moreover, farmers are given information on better healthy living through passage of behavioural change knowledge on balanced diet, healthy foods, crop and livestock diversification, quality food preparation and conservation all geared towards better maternal, infant and children health besides the general household health of the family. Through farmer groups, members share information on personal development which is critical in developing other members' human development indicators.

Mwingi district is located in Eastern Kenya and is a semi-arid region receiving rainfall of between 500-700mm. Mwingi district is a highly food insecure region and livelihood of the residents depend on rain fed agro-pastoralism and honey production. It has high poverty levels with about 60% of the population living in poverty (Galu *et al.*, 2010). Honey production in the district is classified as organic because of minimal or no usage of external inorganic inputs for crop or livestock farming as well as the presence of surrounding forest buffer zones. International Fund for Agricultural Development (IFAD) and International Centre of Insect Physiology and Ecology (ICIPE) jointly initiated the pro-poor program of commercializing organic honey production in 1997 to improve the livelihood of poor residents. They started by forming honey production groups through the help of local community leaders. The farmer groups later together with assistance of IFAD and ICIPE established of Mwingi District Beekeeping and Sericulture Joint Self Help Group composed of subgroups of farmers in different locations in the district. It was later rebranded to Mwingi Honey Marketplace, which process raw honey and markets processed honey and wax as the main by-product. It also provides coordination for all subgroups and linkage to other stakeholders (Raina *et al*., 2009; ICIPE, 2013).

By 2013, Mwingi Honey Marketplace had 52 groups, each having 30-55 members with a grand membership of over 2000 households. The groups undergo thorough vetting by board members of Mwingi Honey Marketplace to ensure that members are committed to the objectives of the organization and composed of smallholder poor farmers before undergoing training and certification process begin. The program has developed several honey collection centres from distant farmers during harvest seasons to minimize transaction costs. ICIPE and government extension officers train farmers on honey production as well as mainstreaming biodiversity conservation in the honey value chain. Trainings in groups are offered to members on hive management, modern techniques on honey production like use Langstroth hives, harvesting and handling, domestication of stingless bee and strategies to have high quality honey production. The products are sold locally and others transported to high value markets in Nairobi. KOAN and Institute of Marketecology (IMO) undertake group certification of production and marketing processes to minimize individual certification cost. Honey Marketplace received international top award in 2009 for its high quality honey during Biofach Trade Fair in Germany (ICIPE, 2013).

Women empowerment component in the production systems includes involvement of women in production and marketing of honey, intensive and frequent trainings on making and type of investment opportunities and general entrepreneurial skills in farmer groups composed of men and women. These knowledge areas are geared towards changing men attitude and perception on subjective capabilities of women common in rural areas. Women are also involved in leadership of the marketing group and farmer sub-groups. Some women are given high yielding Langstroth bee hives by the project to enable them engage in commercial honey production. Nutritional knowledge is passed in farmer groups geared towards behavioral change in the diet for better household health to maximize on the income they receive from the farming activities.

3.2 Sample size and sampling procedure

The required sample size was determined by proportionate to the number of households sampling methodology (Anderson *et al.*, 2007).

$$n = \frac{pqZ^2}{E^2} \quad \ldots \quad (6)$$

Where; n = Sample size; Z= confidence level (α=0.05); p = proportion of the population containing the major interest q = 1-p E= allowable error. Since the proportion of the population was not known, p= 0.5, q= 1-0.5=0.5, Z= 1.96 and E = 0.065. This resulted to a sample of approximately 229 respondents in each of the production system.

In both production systems, smallholder farmers who have actively practiced commercial production for at least three years were the target population. The study followed multistage stratified sampling technique. In Mwingi and Ngong districts, three main divisions in honey and vegetable production were selected based on information from corresponding district ministry of agriculture office. Four locations from each of the three divisions were randomly selected. From each location, stratified random sampling technique was employed to stratify farmers into conventional and certified organic in vegetable production systems while in honey production system, farmers were stratified into organic and certified organic producers. Finally, random sampling was used to select the farmers in the sample in the different strata.

In vegetable production systems, data were collected from conventional producers (also referred as noncertified vegetable producers in this study) and the organic certified producers. In organic honey production system, data was collected among noncertified and certified organic producers. Data collection were through in-depth face-to-face interviews conducted on the sampled farmers by trained enumerators using pre-tested semi-structured questionnaires. Extraction of contextual data were through focus group discussion conducted in each case study site. A draft semi-structured questionnaire was pilot-tested and improved based on the outcome of pilot study.

Household surveys collected information on household portfolio of production activities, inventory of farmer's farm management practices (pest, disease and weed management, soil fertility practices, post-harvest handling of the products) and household characteristics. Further, the survey generated information on household income, household dietary intake, women empowerment, welfare and human development indicators, certified organic production, crop production and marketing and institutional characteristics including group characteristics among others. The questionnaires used for data collection general household survey and women empowerment in agriculture survey are attached in Appendix 1 and 2, respectively. The questionnaire on women empowerment in agriculture was administered to the highest female decision maker in the household. Among vegetable producers, data was collected in 237 households, of which 65% were conventional farmers and 35% were certified organic farmers. Data was collected in 232 households comprised of 48% noncertified and 52% certified farmers engaged in organic honey production. This sample sizes slightly surpassed the minimum sample size estimated of 229 households in each production system.

3.3 Multidimensional poverty measurement

In measuring poverty status, the study used the counting multidimensional methodology developed by Alkire and Foster (2011). Following Alkire and Foster (2011) and Terzi (2013), let $n \times d$, be the matrix of reported attainments in dimensions d in the sample of vegetable and honey producers n be denoted by $\mathrm{P} = \left(p_{ij}\right)$. Thus, the i^{th} household poverty attainment in dimension j is $y_{ij} \geq 0$, such that $i = 1, \cdots, n;\ j = 1, \cdots, d$. Further, there is a weighting vector w, such that the j^{th} element $w_j(1 j =, \cdots, d)$ denoting the applied weights to dimension j and the set $\sum w_j = d$. This implies that summation of the dimensional weights w_j is equal to the total poverty dimensions included in measuring multidimensional poverty d in the study (Terzi 2013).

The poverty deprivation cut-off is denoted by $z_j > 0$ in the j dimension and z represents cut-offs deprivation vector. For vegetable and honey producers a deprivation matrix $G^0 = \left(g_{ij}^0\right)$, with $g_{ij}^0 = w_j$ if $y_{ij} < z_j$ and $g_{ij}^0 = 0$ if $y_{ij} \leq z_j$ was defined. Summation of all each row elements in the matrix resulted in a column count of deprivation vector c, such that the i^{th} household weighted deprivation count was given by $c_i = \sum g_{ij}^0 (i = 1, \cdots, n)$. The definition of a poor household was concluded by selection of a poverty cut-off k, such that $0 < k \leq d$. Therefore, for a household to be considered multidimensional poor, the deprivation count is $c_i \geq k$ had to be met (Alkire and Foster, 2011; Terzi, 2013). The dimensions, indicators and deprivation cut-offs used to measure multidimensional poverty is presented in Table 1.

Table 1: Dimensions, indicators and deprivation cut-offs used in poverty measurement

Dimension and indicators	Description of deprivation cut-offs
Education	
Schooling achievement	Deprived if the household spouses has completed primary level of education
School attendance	Deprived if the household has school aged children not going to school
Standard of living	
Electricity	Deprived if the household has no electricity
Drinking water	Deprived if the household does not have access to safe drinking water or they have to walk over 30 minutes to get safe drinking water
Sanitation	Deprived if the household has no descent pit latrine
Flooring	Deprived if household house is earth
Assets	
Phone	Deprived if the household does not own a mobile phone
Radio and /or television	Deprived if the household does not own at least radio
Vehicle	Deprived if the household does not own at least a bicycle
Health	
Nutrition1	Deprived if the household reports an household dietary diversity score of 6 and below out of the possible 12 food groups
Nutrition2	Deprived if the household relies on relief food or any case of malnutrition in the past 2 years
Access	Deprived if the household has difficulty in meeting basic public hospital bills

The dimensions and indicators included various components of human development, including the Millennium Development Goals, derived from previous studies in developing countries (Batana, 2013; Batana and Duclos, 2010; Chowdhury and Mukhopadhaya, 2012; Terzi, 2013). The dimensions include education, health, standards of living and health which were weighted equally with each dimension having a weight of 1 as in previous studies (Alkire and

Foster, 2011; Botana, 2013; OPHI, 2013). The indicators in each dimension were further equally weighted following Alkire and Foster (2011) methodology, of "nested weights structure". For a household to be defined multidimensional poor, a poverty cut-off of 1/3 of the total weighted indicators was used as applied in past studies in sub-Saharan Africa (Batana, 2013; OPHI, 2013; Terzi, 2013).

3.4 Measurement of WEIA

The methodology of measuring WEIA as proposed by Alkire *et al*. (2013) was used in the study because it reflects the diverse aspects in women empowerment literature. Alkire *et al*. (2013) provides a detailed review of other studies on women empowerment measurement and the details of weights for each subcomponent in different dimensions. However, some modifications were made in measuring different dimensions of WEIA. Five dimensions of WEIA included empowerment in production, income, resource, leadership and time. The production dimension was comprised of; a) women input in production decisions involving cash and food crop farming, livestock keeping and aqua farming, and b) autonomy in production involving agricultural and livestock production, type of crops grown, type of inputs used, when and who to deliver the produce to the market.

However, instead of limited ranked scale and binary variables used to measure levels of WEIA by (Alkire *et al*., 2013), the present study opted for a range of between zero and ten percent, which was later transformed to a range of between zero and 100 per cent. This was found necessary to get actual stated level of women participation in decision making in various components and reducing measurement errors involving use of binary use. The argument is that women with low level of participation in agricultural decision making might feel they do not participate if asked questions requiring binary responses, but in reality they participate though not much. Thus, a scale would provide a chance for women to rank their real participation, improving measurement of level of decision making. This approach of measurement was used in all subsequent components/indicators of dimensions of women empowerment.

In resource dimension, the indicators comprised of level of ownership of land and other assets, decision on sale, purchase and transfer of land and other assets beside decision regarding acquisition and use of credit. The income dimension was used to measure women household decision making regarding income generated. The subcomponents of the dimension were; a) women participation in decisions on income generated from cash and food crop farming, livestock keeping and aqua farming, and b) women feelings on decisions regarding her salaried or wage employment as well as making major and minor household expenditure if she wanted. Leadership dimension of empowerment saw major change in its components. Instead of using group membership and speaking in public as proposed by Alkire *et al*. (2013), the study used the "authentic leadership" measurement by Walumbwa *et al*. (2008) used in measuring leadership in business world. It captured four important aspects of leadership which were found more convincing of self-awareness, relational transparency, internalized moral perspective and balanced processing of women. The questions on how the study measured leadership dimension is shown in appendix 3 modified from the sample questionnaire in the National University blog by Walumbwa and associates. Leadership indicator measurement by a binary response of belonging to a group as proposed by Alkire *et al*. (2013) could be an inadequate indicator, since group membership results more to social capital formation than leadership (Christoforou, 2011; Tumbo *et al*., 2013). Time dimension was measured by level of satisfaction on time available for leisure and the workload for women. The overall index was computed from the five dimensions using equal weights of each dimension as proposed by Alkire *et al*. (2013).

3.5 Analytical framework

3.5.1 Modelling heterogeneity treatment effects of certified organic production on household income

Variability across units of analysis has received remarkable acknowledgment in social studies with recognition that there exist differences in response to treatments from one individual to another. This has made literature on impact methodology to recognize and allow for population heterogeneity in causal inferences (Heckman and Vytlacil, 2005; Xie, 2007; Xie *et al*., 2012). In this study, the populations of interest were smallholder vegetable and honey producers. This subsection presents the modelling used to determine the heterogeneity in effects of certified organic production on household income (Y) leading to identification of who benefits most from the schemes. Therefore, certified organic production is the treatment (denoted by C) where $C_i = 1$ if the i^{th} farmer is certified organic producer and $C_i = 0$, if otherwise. Likewise, let

Y_{1i} and Y_{0i} represent the total household income for certified and noncertified organic farmers, respectively. Hence, if participation in certified organic production is random, comparison of certified and noncertified farmers would result in Average Treatment Effect (ATE) under propensity score matching as;

$$ATE = E(Y_1 - Y_0) \quad (6)$$

Equation (6) is defined for the whole population, but the interest of the study is to define the certification effects for subpopulation, in order to determine how different subpopulation household income is affected by the treatment (participation in certified organic production systems). This results into two quantities being estimated. First is the Treatment effect of the Treated (TT) resulting from the average difference of certification among farmers who were actually treated given by;

$$TT = E(Y_1 - Y_0 | C = 1) \quad (7)$$

Second is the average difference among farmers who were not certified, which is known as Treatment effect of the Untreated (TUT) given by;

$$TUT = E(Y_1 - Y_0 | C = 0)$$

(8)

Therefore, if certification effect is homogenous across all vegetable and honey producers, ATE, TT and TUT values will be equal. But if different, it is an indication of heterogeneity in certification effect. However, ATE, TT and TUT statistics “ignores’ the heterogeneity within group among farmers (Brand and Xie, 2010).

Hence, there is need to establish group level comparisons to determine group level causal inference. Existing heterogeneity among vegetable and honey producers as a result of contextual and socio-economic conditions makes the groups of certified and noncertified producers not comparable. Thus, participation in such emerging schemes faces the problem of self-selection, as farmers tend to self-select themselves to participate in the schemes. This is caused by differences in their background characteristics coupled with anticipation of monetary and non-monetary benefits (Xie *et al*., 2012).

Using equation (6) to determine causal inference ATE statistic results in two sources of bias. First is the “pretreatment heterogeneity bias” or “endogeneity”, which is average difference occurring in cases of non-certification because of unobserved factors correlated with organic certification. Second is the "treatment effect heterogeneity bias", which is the difference between certified and noncertified farmers (TT-TUT) (Brand and Xie, 2010; Xie *et al.*, 2012). To draw causal inference of organic certification on household income, there was need to introduce the "strongly ignorable treatment assignment" assumption that has two implications (Brand and Xie, 2010). First is that organic certification is independent of household income given a number of covariates denoted by X such that $C \perp (Y_0, Y_1) | X$ and second, that the probability of receiving certification for all values of X: $0 < P(C = 1|X) < 1$ for all X is positive, as applied in other studies (Brand and Xie, 2010; Xie *et al.*, 2012; Mutuc *et al.*, 2013).

In presence of heterogeneity, the following equation is estimated involving the two components of heterogeneous bias;

$$Yi = \alpha_i + \partial_i C_i + \beta' X_i + \upsilon_i \qquad (9)$$

where, α_i is the pretreatment heterogeneity, ∂_i is the treatment heterogeneity, β_i is the parameters to be estimated for covariates X_i and υ_i is the residual term. However, individual level heterogeneity is unidentifiable since α_i and ∂_i are inseparable from υ_i without invoking the "ignorability" assumption. Nonetheless, since X is typically multidimensional, conditioning X is difficult because of "curse of dimensionality" (Brand and Xie, 2010). This implies that increasing the number of characteristics used in matching certified and noncertified organic producers leads to reduction in likelihood of finding an exact match and sometimes inclusion of relatively smaller number of characteristics can result in farmers remaining unmatched (Mutuc *et al.*, 2013). The solution is to invoke the "ignorability" assumption, where Rosenbaum and Rubin (1983) find it sufficient conditioning the propensity score as a function of X. Propensity score is the likelihood of being certified organic producer given a set of covariates X (Brand and Xie, 2010) given by;

$$P = p(C_i = 1|X) \qquad (10)$$

To evaluate heterogeneity in treatment effects of organic certification on household income, ∂ in equation 9 was decomposed to generate nonparametric function of propensity score and to reveal the pattern of certification to household income using linear hierarchical model (Brand and Xie, 2010). Vegetable and honey producers are divided according to farm and farmer characteristics and propensity scores to participate in certified organic farming was predicted. Further, determination of whether vegetable and honey producers' propensity to participate in organic certified production system is associated with the variances in total household income was conducted. To achieve this, two approaches proposed by Xie *et al.* (2012) were used; stratification multilevel and matching-smoothing.

In stratification multilevel approach of estimating heterogeneous treatment effects, probit regression model is estimated to predict propensity scores of being certified organic farmer for vegetable and honey producers given a set of farm and farmer characteristics. The vegetable and honey producers were then grouped separately into a balanced score strata at 1% significant level before estimating the effect of certification to the balanced propensity score strata's (Level-1 slope) generated using ordinary least square regression model. Using, the variance-weighted least square regression of each strata certification effect a linear trend was then generated (Level-2 slope).

In matching-smoothing approach of estimating heterogeneous treatment effects, matching is conducted based on propensity score of certified and the noncertified producers before the data was transformed into certified-noncertified comparisons for vegetable and honey producers. Nonparametric smoothing device was then used to generate graphs of organic certification effect as a function of propensity score. Worth noting is that the vegetable and honey production systems are independent and this analysis was conducted separately.

Propensity matching technique used in computing heterogeneity in effect of certified organic farming is critical in controlling for selection caused by observable farmers' social, economic and institutional characteristics. The main concern in the analysis is selection bias from unobservable characteristics. Instrumental variable approach is one way that could be used to control for selection bias due to unobservable characteristics. However, the problem of "weak instruments" when using instrumental variable technique may affect final inference made on effect of organic certification on household income (Hausman, 2001; Mutuc *et al.* 2013). Nevertheless, the study relied on Altonji *et al*. (2005) methodology to evaluate the magnitude of bias resulting from selection on unobservables after controlling for observable characteristics using the matching techniques. The approach computes a ratio (usually denoted by τ). The ratio τ is interpreted as the shift in distribution of unobservable characteristics that explains the way observed organic certification effect based on observable characteristics. In case τ is substantively greater than 1.0, then selection on unobservables is not a big issue and if τ is close or less than 1, then selection on unobservables is a big issue (Altonji *et al*., 2005; Altonji *et al*., 2008; Rejesus *et al*., 2011).

Description of variables used in heterogeneous treatment effect analysis is presented in Table 2. The variables were drawn from previous studies on related technology adoption in developing countries (Bolwig *et al.,* 2009; Fort and Ruben, 2009; Kamau *et al.*, 2010; Di Falco *et al*., 2011; Gopal and Rattanasuteerakul, 2011; Rao and Qaim, 2011; Asfaw *et al*., 2012; Kersting and Wollni, 2012; Kassie *et al*., 2013; Kleemann and Abdulai, 2013; Negash and Swinnen, 2013; Teklewold *et al*., 2013; Nunes *et al*., 2014).

Table 2: Description of variables used in the heterogeneous treatment effect model

Variables	***Description of the variables***
Education head [a]	Education level of the household head
Gender head	Dummy=1 if household head is male, 0 otherwise
Head age	Age of household head in years
Household size	Household size(numbers)
Off-farm employment	Dummy=1 if household head participated in off-farm activities, 0 otherwise
Farm size	Farm size in acres
Agricultural assets ('000)	Value of agricultural assets(KES)
System of keeping livestock	Dummy=1 closed system of keeping livestock , 0 otherwise
Information sources	
Farmer-to-farmer Extension	Dummy=1 if the household head got information from fellow farmers, 0 otherwise
Government extension	Dummy=1 if the household head got information from government extension workers, 0 otherwise
Non-governmental Extension	Dummy=1 if the household head got information from non-governmental organization extension workers, 0 otherwise
Print and visual media	Dummy=1 if the household head got information from newspapers, televisions and other related media, 0 otherwise
Number of trainings	Number of trainings received in a year
Credit access	dummy=1 had access to credit , 0 otherwise
Market distance	Distance to the nearest produce market (Kilometres)
Household social capital	
Density of membership	Density of membership (numbers)
Group heterogeneity [b]	Group heterogeneity index
Meeting attendance	Meeting attendance index (meetings attended/ scheduled meetings)
Decision index	Level of decision making in groups, 0-100%
Trust	Level of trust among group members , 0-100%
Income from vegetable/honey	Annual income from corresponding vegetable and honey production in (KES)
Total household income	Summation of annual income from crops (value of crop produce less cost of inputs, livestock income (sum of income from sale of live animals less cost of inputs and of purchasing live animals), household members' salary and wages, business income and remittances

a). Education measured in terms of 1=not gone to school 2=primary 3=secondary 4= tertiary 5= university. b) The heterogeneity index derived from questions of whether members were from same neighbourhood, occupation, kin-group, economic status, religion, gender, education level and age group.

3.5.2 Modelling effect of certified organic farming on poverty

This subsection presents the modelling technique used to determine the effect of participation in certified organic production on poverty among vegetable and honey smallholder producers in Kenya. However, unobserved characteristics that influence household participation in organic certification scheme decision are likely to correlate with unobservable characteristics that influence the poverty status. Ignoring endogeneity of participation in certified organic production would result in biased estimated parameters. To address the endogeneity problem, the endogenous switching probit model was used, which accounts for correlation in unobserved characteristics in the organic participation decision and the poverty status, which is the outcome variable. Following Lokshin and Sajaia (2011), consider a household with two binary outcome equations (whether multidimensional poor or not) and the criterion function C_i (household participation in organic certified scheme) that determines the regime faced by the household. The potential values are represented as;

$$C_i = 1 \text{ if } \alpha Z_i + \mu_i > 0 \tag{11a}$$

$$C_i = 0 \text{ if } \alpha Z_i + \mu_i \leq 0 \tag{11b}$$

$$p_{1i}^* = \beta_1 X_{1i} + \varepsilon_{1i} \qquad p_{1i} = I(p_{1i}^* > 0) \tag{12a}$$

$$p_{0i}^* = \beta_0 X_{0i} + \varepsilon_{0i} \qquad p_{0i} = I(p_{0i}^* > 0) \tag{12b}$$

where p_{1i}^* and p_{1i}^* are latent variables (household poverty status) that defines observed poverty status p_1 and p_0 (whether the household is multidimensional poor or not, respectively), Z is a vector of exogenous variables determining participation in certified organic schemes, X_i is a vector of exogenous variables determining poverty status, α and β are the vector of parameters to be estimated while μ_i, ε_{1i} and ε_{0i} are the disturbance terms.

The observed poverty status p_i is defined as $p_i = p_{1i}$ if $C_i = 1$ and $p_i = p_{0i}$ if $C_i = 0$. With the assumption of joint normal distribution of μ_i, ε_{1i} and ε_{0i} with a mean of zero, the correlation matrix is written as;

$$\Omega = \begin{pmatrix} 1 & \rho_0 & \rho_1 \\ & 1 & \rho_{10} \\ & & 1 \end{pmatrix} \quad (13)$$

where ρ_0 is the correlation between ε_0 and μ, ρ_1 is the correlation between ε_1 and μ while ρ_{10} is the correlation between ε_0 and ε_1. Consequently, the log likelihood function for the model is given by;

$$Ln(\xi) = \sum_{C_i \neq 0, p_i \neq 0} \omega_i In\{\Phi_2(X_{1i}, \beta_1, Z_i\alpha, \rho_1)\} + \sum_{C_i \neq 0, p_i = 0} \omega_i In\{\Phi_2(-X_{1i}\beta_1, Z_i\alpha, -\rho_1)\}$$

$$+ \sum_{C_i = 0, p_i \neq 0} \omega_i In\{\Phi_2(X_{0i}\beta_0, -Z_i\alpha, -\rho_0)\} + \sum_{C_i = 0, p_i = 0} \omega_i In\{\Phi_2(-X_{0i}\beta_0, -Z_i\alpha, \rho_0)\} \quad (14)$$

where ω_i is an optional weight for the i^{th} household and Φ_2 is the cumulative function of bivariate normal distribution (Lokshin and Sajaia, 2011). Previous studies have used the switching probit regression model in social research (Lokshin and Sajaia, 2011; Floro and Swain, 2013; Gregory and Coleman-Jensen, 2013).

The advantage of endogenous switching probit model specified in equation (14) is the possibility of deriving probabilities in counterfactual cases for household's poverty status on participation in certified organic vegetable and honey production systems. Following Aakvik *et al.* (2000) and Lokshin and Sajaia (2011) two cases were defined as;

$$TT(x) = \Pr(p_1 = 1 | C = 1, X = x) - \Pr(p_0 = 1 | C = 1, X = x)$$

$$= \frac{\Phi_2(X_1\beta_1, Z\alpha, \rho_1) - \Phi_2(X_0\beta_0, Z\alpha, \rho_0)}{F(Z\alpha)} \quad (15a)$$

$$TU(x) = \Pr(p_1 = 1 | C = 0, X = x) - \Pr(p_0 = 1 | C = 0, X = x)$$

$$= \frac{\Phi_2(X_1\beta_1, -Z\alpha, -\rho_1) - \Phi_2(X_0\beta_0, -Z\alpha, -\rho_0)}{F(-Z\alpha)} \quad (15b)$$

where F is the cumulative function of the univariate normal distribution. Equation (15a) computes the effect of treatment on the treated (TT), which is the difference between the predicted probability of being multidimensional poor for certified organic households and the probability of being poor for household had they not participated in certified organic production. Computing the average of TT(x) on households engaged in certified organic production results in the average treatment effect on the treated (ATT). The effect of the treatment on the untreated (TU) was computed by equation (15b), which is the expected effect on poverty status if noncertified households had participated in certified production scheme. Computing the average of TU(x) of households that did not engage in organic certified production results in the average treatment effect on the untreated (ATU) (Aakvik *et al.*, 2000; Lokshin and Sajaia, 2011). The descriptions of the variables used in the switching probit model are presented in Table 3.

Table 3: **Description of variables used in endogenous switching probit model**

Variables	**Description of the variables**
Education head [a]	Education level of the household head
Gender head	Dummy=1 if the household head is male, 0 otherwise
Head age	Age of the household head in years
Household size	Household size(numbers)
Off-farm employment	Dummy=1 if the household head participated , 0 otherwise
Farm size	Farm size in acres
Agricultural assets (‘000)	Value of agricultural assets(KES)
System of keeping livestock	Dummy=1 closed system of keeping livestock , 0 otherwise
Number of extension	Number of contacts with agricultural extension officers in the past 12 months in the past 12 months
Number of trainings	Number of agricultural trainings received
Credit access	Dummy=1 Had access to credit , 0 otherwise
Market distance	Distance to the nearest produce market(Km)
Information sources	
Farmer-to-farmer Extension	Dummy=1 if the household head got information from fellow farmers, 0 otherwise
Government extension	Dummy=1 if the household head got information from government extension workers, 0 otherwise
Non-governmental Extension	Dummy=1 if the household head got information from non-governmental organization extension workers, 0 otherwise
Print and visual media	Dummy=1 if the household head got information from newspapers, televisions and other related media, 0 otherwise
Household social capital	
Density of Membership	Density of membership (numbers)
Group heterogeneity [b]	Group heterogeneity index
Meeting attendance	Meeting attendance index (meetings attended/ scheduled meetings)
Decision index	Decision making in the groups, 0-100%
Trust	Level of trust among group members , 0-100%
Multidimensional poor	Multidimensional poverty index

a. Education measured in terms of 1=not gone to school 2=primary 3=secondary 4= tertiary 5= university. b. The heterogeneity index derived from questions of whether members were from the same neighbourhood, occupation, kin-group, economic status, religion, gender, education level and age group.

3.5.3 Modelling determinants of WEIA

3.5.3.1 Modelling determinants of dimensions of WEIA

To control for potential endogeneity bias of organic participation, the study used a two-step estimation procedure. In the first stage, a probit model was estimated to determine the factors influencing participation in certified organic production systems in vegetable and honey producing systems. From the results of first stage probit model, the predicted values for participation were obtained for each household. Therefore, instead of having a dummy variable of certified organic participation (which was the dependent variable in the first stage); the predicted values of certified organic participation was used as independent variable in the second stage to capture the effect of certified organic farming together with other socioeconomic and cultural on dimensions and the overall index of WEIA (Wollni *et al*., 2010). Second stage involved assessment of determinants of WEIA dimensions using multivariate two limit Tobit model (described in this subsection) and univariate two limit Tobit model (described in subsection 3.5.3.1). This was attributed to overall index of WEIA being derived from all the five dimension of WEIA, hence would be erroneous to estimate its determinants together with dimension specific determinants using multivariate two limit Tobit model. The idea behind usage of the two tobit models is to understand the determinants of dimensions and overall index of women empowerment, which might help project planners in reorienting the programmes to ensure an all-round empowered women in society.

The use of ordinary least square would have been possible in the analysis, but presence of zero observation in some dimensions of WEIA besides having lower and upper limits would lead to biased and inconsistent estimates (Ma *et al*., 2006). Tobit model estimates are consistent because of truncation of dimensions of WEIA at zero. The two limit multivariate Tobit model allows for unobservable characteristics that determine women empowerment in one dimension to correlate with those of other dimensions of WEIA. The two limits multivariate Tobit model have used in several studies in agriculture (Gillespie and Mishra, 2011; Ali *et al*., 2012).

Let the five dimensions of WEIA be donated by d with n observation and X a vector of variables including predicted values of organic certified production participation (*ocertprod)* variable hypothesized to be determining d, then the observed WEIA dimension we_{ih} are determined by;

$$we^*_{ih} = X'_{ih}\beta_i + \varepsilon_{ih}, \qquad 1 \le i \le d, \quad 1 \le h \le n \tag{16}$$

$$we_{ih} = \begin{cases} we^*_{ih} & if \quad we^*_{ih} > 0 \\ 0 & if \quad we^*_{ih} \le 0 \end{cases} \tag{17}$$

where we^*_{ih} is the latent variable and $\varepsilon_h = (\varepsilon_{1h}, \varepsilon_{2h}, ..., \varepsilon_{dh})' \sim N_d(0, \Omega)$. The dimensions of β_i is $s_i \times 1$ and Ω is a $d \times d$ symmetric positive matrix. The observed value of we_{ih} equals the true value if $we^*_{ih} > 0$; otherwise, the observed value of we_{ih} is left censored to be zero (Ma *et al.*, 2006). The latent for level of women empowerment for the i^{th} dimension of the h^{th} woman is denoted by we^*_{ih} and the observed index of empowerment is we_{ih}, which is either positive or zero. Huang (2001) and Ma *et al.* (2006) expressed the system of equations as;

$$\begin{bmatrix} we^*_{1h} \\ we^*_{2h} \\ \vdots \\ we^*_{dh} \end{bmatrix} = \begin{bmatrix} X'_{1h} & 0 & \cdots & 0 \\ 0 & X'_{2h} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & X'_{dh} \end{bmatrix} \otimes \begin{bmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_h \end{bmatrix} + \begin{bmatrix} \varepsilon_{1h} \\ \varepsilon_{2h} \\ \vdots \\ \varepsilon_{dh} \end{bmatrix} \tag{18}$$

This can be rewritten as;

$$we^*_h = X_h\beta + \varepsilon_h, \qquad h = 1, 2, \cdots, n \tag{19}$$

where $we^*_h = (we^*_{1h}, we^*_{2h}, ..., we^*_{dh})'$, $X_h = diagram\ (X'_{1h}, X'_{2h}, \cdots X'_{dh})$, and $\beta = (\beta'_1, \beta'_2, \cdots \beta'_d)'$ is a $s \times 1$ vector with $s = \sum_{i=1}^{h} h_i$. Worth noting in all this specification is that some women might not be having zeros as the level of empowerment (they do not participate in decision making at all) in any of the five dimension, which implies there is censoring points at point zero. Therefore, possible combination of WEIA at censoring points is 2^d represented by a $2^d \times 1$ vector C_s, c =1, 2, …, 2^d. The likelihood function accounting for all censoring combinations in all observations is specified as;

$$L(WE; \beta, \Omega) = \prod_{h=1}^{n} L_h^{C_s}(we_h; \beta, \Omega) \tag{20}$$

where WE=$(we'_1, we'_2, \cdots, we'_n)'$ and $L_h^{C_s}$ C shows the likelihood combination that the dimension specific level of women empowerment h falls in regime s.

3.5.3.2 Modelling determinants of the overall WEIA index

To determine the effect of participation in certified organic production systems and other socioeconomic and cultural variables on the overall WEIA index, the study used univariate Two-Limit Tobit model. Its structural equation is written as;

$$owe_i^* = X_i\alpha + \upsilon_i \tag{21}$$

where, owe_i^* is a latent variable of overall WEIA for the i[th] woman, X is a vector of independent variables postulated to be determining the level of women empowerment including participation in certified organic production predicted values estimated by probit model explained in first paragraph of this sub-section (as the certified organic participation variable). The $\alpha's$ are parameters of the independent variables to be estimated and ε is the error term and is assumed to be independently distributed, normally distributed with a mean of zero and a constant variance. The model takes into account censoring both from below and above. The generic measurement equation is written as:

$$\begin{aligned} owe_i &= owe^* \;\; if \;\; owe^* > \tau \\ owe_i &= \tau_{owe} \;\; if \;\; owe^* \leq \tau \end{aligned} \tag{22}$$

Typically, the Two Limit Tobit model assumes that $\tau = 0$, which means the data is censored at zero. However, the overall WEIA range between 0 per cent and 100 per cent (Tobin, 1958). Thus, substitute τ in equation (7) results into:

$$owe_i = owe^* \;\; if \;\; 0 < owe^* < 1$$

$$owe_i = 0 \;\; if \;\; owe^* \leq 0$$

(23)

$$owe_i = 1 \;\; if \;\; owe^* \geq 1$$

The model assumes that there is an underlying WEIA index equal to $x_i\alpha + \upsilon_i$, which was observed only when it is some number between 0 per cent and 100 per cent; otherwise owe_i^* qualifies as an unobserved latent variable (Greene, 2002).

The variables hypothesised to determine the level of WEIA is presented in Table 4. Husband characteristics could play role in women empowerment process (Anderson and Eswaran, 2009). They included level of education, spousal age gap (difference between age of woman (wife) from that of man (husband) in a household) and participation in off-farm activities. The study hypothesis that husbands participation in off-farm and higher education could result to higher levels of women empowerment. This was on the premise that education and off-farm activities participation facilitates exposure to information and knowledge, which could reduce the subjective opinion on incapability of women involvement in agricultural decision making. Higher spousal age gap is associated in literature with hegemony on the part of younger spouse (Guilbert, 2013).

Women social and economic characteristics were also included as determinants of WEIA. Higher level of education of women could positively influence WEIA. Higher education achievement increases status of women in family units and skills critical in decision making. Participation in off-farm income activities by women is also important in enhancing women bargaining power because it enhances self-reliance (Jayaweera, 1997). The variable of whether the woman is the family head was also included to capture effect of gender of the household head.

Table 4: Description of variables hypothesised to determine the level of WEIA

Variables	**Description of the variable**
Offarm_man	Off-farm activity participation by the husband , 1=Yes 0=No
Offarm_fem	Off-farm activity participation by the wife, 1=Yes 0=No
Educ_ man [a]	Education level of the husband
Educ_ fem [a]	Education level of the wife
Female age	Age of the household head(Years)
Head _ fem	Whether the wife is the household head, 1=Yes 0=No
Marry age	Age the wife was married in years
Age gap	Spousal age gap in years (husband age-wife age)
Wgroup_het[bc]	Group heterogeneity index of wife
Wmeet index[b]	Wife's, Meeting attendance index (meetings attended/ scheduled meetings)
Wdensity [b]	Number of active groups household wife involved in
Wtrust [b]	Level of trust in groups the wife is involved in (0-100%)
Ocertprod	Propensity to be organic certified producer

Notes: Figures in parenthesis are standard errors of the respective means. a. Education measured in terms of 1=not gone to school 2=primary 3=secondary 4= tertiary5=university b. Women level social capital dimensions. c. The woman heterogeneity index derived from questions of whether members in women groups were from the same neighbourhood, occupation, kingroup, economic status, religion, gender, education level and age group.

Age of women could also determine level of WEIA and the study hypothesizes the effect to be either positive or negative. Older women could be more empowered because of their experience in marriage. On the contrary, younger women could be more empowered because of tendency to have higher levels of education and higher mobility, which leads to exposure in wider areas of self-empowerment. The age at marriage of women may affect their decision making ability (Guilbert, 2013). Early marriages are prone in rural areas and the study hypothesizes that it could negatively influence WEIA in honey producing households. Women social capital dimensions as measured by Grootaert (1999) were also included because it could be a source of information through trainings and interactions other than providing platform to develop women decision making skills through their involvement in group activities. The value of agricultural assets was included as an indicator of wealth to assess the effect of wealth on women empowerment. Land size could also determine level of empowerment, as women are greatly involved in providing agricultural labour force.

3.5.4 Modeling effect of participation in certified organic production on HDDS

To determine the effect of participation in certified organic production systems on smallholder HDDS, the analysis faces the problem of self-selection. Hence, estimation using Poisson regression with a dummy variable of participation in certified organic production systems as one of the explanatory variables would yield biased estimates even in conditions where household characteristics are controlled since HDDS is count data. Further, farmers who participate in certified organic production system may have systematic different characteristics from the farmers who did not and they may have participated in certified organic production systems based on expected benefits. As a result, unobserved household and farm characteristics may affect both the decision to participate in certified organic production systems and the HDDS occasioning inconsistent estimates.

The study addresses the endogeneity problem and the structural differences in the subgroups by use of endogenous switching Poisson regression model. In the first stage of the model, the probit regression is used to determine the explanatory variables that influence the probability of participating in certified organic production system. In contrast, the second stage estimates the determinants of the HDDS conditional on participation or not in certified organic production systems. The advantage of the endogenous switching Poisson regression model is that it enables computation of the actual and counterfactual HDDS of the certified and the noncertified producers. Let the latent variable capturing the expected HDDS from participation in certified organic production be denoted by $OC_i^* > 0$. Hence, the probit model is specified as;

$$OC_i^* = Z_i\alpha + \eta_i \quad \text{with} \quad OC_i = \begin{cases} 1 & \text{if} \quad OC_i^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

(24)

where OC_i is a dummy variable which is 1 when the household participates in certified organic production and 0 if otherwise, Z_i represents a set of explanatory variables influencing the decision of participating in certified production scheme, α is the parameters to be estimated and η_i is the error term with mean of zero and variance of σ_η^2 (Akpalu and Normanyo, 2013). To estimate the determinants of HDDS by the participating and non-participation households in the certified production schemes, the model is specified as;

Regime 1 (Certified producers): $E[HDDS_i | x_i, OC_i = 1] = \exp(x_i\beta_{oci} + \varepsilon_{1i})$ (25a)

Regime 0 (Non-certified producers): $E[HDDS_i | x_i, OC_i = 0] = \exp(x_i\beta_{cfi} + \varepsilon_{0i})$ (25b)

where $HDDS_i$ denotes household dietary diversity score and participation in certified organic production systems (OC) status is 1 for the certified producers and 0 for the noncertified producers, x is a vector of explanatory variables that determine the expected HDDS, β is the parameters to be estimated and ε_i is the error terms. The error terms in equation 6, 7a and 7b are assumed to have a mean of zero, trivariate normal distribution and covariance matrix $\sum$ (that is, $((\eta, \varepsilon_1, \varepsilon_0) \sim N_3(0, \Sigma))$, such that;

$$\Sigma = \begin{pmatrix} \sigma_1^2 & \sigma_{10} & \sigma_{1\eta} \\ \sigma_{10} & \sigma_0^2 & \sigma_{0\eta} \\ \sigma_{1\eta} & \sigma_{0\eta} & 1 \end{pmatrix} \quad (26)$$

The estimation is based on nonlinear least square estimation by first computing the probit using maximum likelihood and then computing an estimator which Zhang and Song (2007) referred to it as "Terza estimator" analogous to the Heckman's inverse mills ratio before using the nonlinear least square in the second stage (Coulson *et al.*, 1995; Terza, 1998; Zhang and Song 2007). Terza (1998) showed that the conditional mean function is given by;

$$E(HDDS_i | OC_i = 1) = \exp(x_i \beta^*) * \frac{\Phi(Z_i\alpha + \theta)}{\Phi(Z_i\alpha)} \quad (27)$$

Where β^* is similar to β apart from constant term which is multiplied by $\frac{\sigma^2}{2}$, $\theta = \rho\sigma$ and $\Phi(.)$ is the standard normal cumulative density function. When $\rho = 0$ or $\sigma = 0$, then $\frac{\Phi(Z_i\alpha + \theta)}{\Phi(Z_i\alpha)} = 1$ an indication of no selection bias.

Hence using the "Terza estimator" the nonlinear least square estimation of the determinants of HDDS are estimated as;

$$E(HDDS_i | x_i, OC_i = 1) = \exp\left\{ x_i \beta_{oc} * \frac{\Phi(Z_i\alpha + \theta_1)}{\Phi(Z_i\alpha)} \right\} \quad (28a)$$

$$E(HDDS_i | x_i, OC_i = 0) = \exp\left\{ x_i \beta_{cf} * \frac{1 - \Phi(Z_i\alpha + \theta_0)}{1 - \Phi(Z_i\alpha)} \right\} \quad (28b)$$

Following Terza (1998), the second stage involves estimation by minimizing nonlinear least squares such that;

$$((\hat{\beta}_m, \hat{\theta}_m) = \arg\min \sum_{i/M_i=1} \left\langle HDDS_i - \exp(x_i \beta_m) * \frac{\Phi(Z_i\hat{\alpha} + \theta_m}{\Phi(Z_i\hat{\alpha})} \right\rangle^2$$

(29a)

$$(\hat{\beta}_c, \hat{\theta}_c) = \arg\min \sum_{i/M_i=0} \left\langle HDDS_i - \exp(x_i \beta_c) * \frac{1 - \Phi(Z_i\hat{\alpha} + \theta_c}{1 - \Phi(Z_i\hat{\alpha})} \right\rangle^2 \quad (29b)$$

The implication is that the sign of θ and its significance indicates the correlation between unobservables in determinants of HDDS in the two regimes thus indication of endogeneity bias (Coulson *et al.*, 1995; Terza, 1998). A number of past studies have used similar methodology (Terza, 1998; McGeary and French, 2000; Kenkel and Terza, 2001; Zhang and Song 2007). The variables used in the endogenous switching poisson regression model are presented in Table 5.

Table 5: Description of the variables used in of endogenous switching Poisson regression model

Variables	Description of the variables
Education head [a]	Education level of the household head
Gender head	Dummy=1 if the household head is male, 0 otherwise
Head age	Age of the household head in years
Household size	Household size(numbers)
Off-farm income	Dummy=1 if the household head participated , 0 otherwise
Land size	Farm size in acres
Agricultural assets (‘000)	Value of agricultural assets(KES)
System	Dummy=1 closed system of keeping livestock , 0 otherwise
Number of extension	Number of contacts with extension officers
Number of trainings	Number of trainings received
Credit access	dummy=1 Had access to credit , 0 otherwise
Market distance	Distance to the nearest produce market(Km)
Household social capital	
Density of membership	Density of membership (numbers)
Group heterogeneity [b]	Group heterogeneity index
Meeting attendance	Meeting attendance index (meetings attended/ scheduled meetings)
Decision index	Decision making in the groups, 0-100%
Trust	Level of trust among group members , 0-100%
Education husband [a]	Education level of the husband
Education wife [a]	Education level of the wife
Household size ae	Household size in adult equivalents
Household Income ‘000	Total household income(KES)
Price of cereals	Price of maize per kilogram
Price of roots/tubers	Price of sweet potatoes per bunch
Price of vegetables	Price of kales per handful
Price of fruits	Price of mangoes per kilogram
Price of meat	Price of meet per kg
Price of eggs	Price of eggs per 30 egg crate
Price of pulses	Price of beans per kilogram
Price of milk	Price of milk per litre
Price of edible oil	Price of cooking oil per kilogram
Price of sugar	Price of sugar per kilogram
Price of beverages	Price of tea leaves per kilogram
Price of fish	Price of fish per kilogram
HDDS	Household dietary diversity score
Women empowerment	Women empowerment in agriculture index , 0-100%

Notes: a. Education measured in terms of 1=not gone to school 2=primary 3=secondary 4= tertiary 5= university. b. The heterogeneity index derived from questions of whether members were from the same neighbourhood, occupation, kingroup, economic status, religion, gender, education level and age group

Conditional expectation, treatment and heterogeneity effects

The advantage of the endogenous switching Poisson regression model is that comparison of the expected observed and counterfactual HDDS can be made. In this study, comparisons of the expected HDDS of households that participated in certified organic production systems (equation (30a)) with respect to households that did not participate in organic certified production (equation (30b)). Investigation was conducted on expected HDDS for households in the counterfactual case that the households participating in organic certified production did not participate (equation (30c)) and in the case that the noncertified producers were certified (equation (30d)) (Zhang and Song 2007; Di Falco *et al.*, 2011; Akpalu and Normanyo, 2013). The conditional expectations for the four cases are presented in Table 5 and they are computed as follows;

$$E(HDDS_{1i}|x_i, OC_i = 1) = \exp\left\{x_i\beta_{oc} * \frac{\Phi(Z_i\alpha + \theta_1)}{\Phi(Z_i\alpha)}\right\} \quad (30a)$$

$$E(HDDS_{2i}|x_i, OC_i = 0) = \exp\left\{x_i\beta_{cf} * \frac{1-\Phi(Z_i\alpha + \theta_0)}{1-\Phi(Z_i\alpha)}\right\} \quad (30b)$$

$$E(HDDS_{2i}|x_i, OC_i = 1) = \exp\left\{x_i\beta_{cf} * \frac{\Phi(Z_i\alpha + \theta_1)}{\Phi(Z_i\alpha)}\right\} \quad (30c)$$

$$E(HDDS_{1i}|x_i, OC_i = 0) = \exp\left\{x_i\beta_{oc} * \frac{1-\Phi(Z_i\alpha + \theta_0)}{1-\Phi(Z_i\alpha)}\right\} \quad (30d)$$

Moreover, according to Heckman *et al.* (2001) and Di Falco *et al.* (2011) to get more insights on the effects the following effects were computed from equations 30, such that;

TT= $E(HDDS_{1i}|x_i, OC_i = 1) - E(HDDS_{2i}|x_i, OC_i = 1)$ (31a)

TU= $E(HDDS_{1i}|x_i, OC_i = 0) - E(HDDS_{2i}|x_i, OC_i = 0)$ (31b)

BH1= $E(HDDS_{1i}|x_i, OC_i = 1) - E(HDDS_{1i}|x_i, OC_i = 0)$ (31c)

BH2= $E(HDDS_{2i}|x_i, OC_i = 1) - E(HDDS_{2i}|x_i, OC_i = 0)$ (31d)

Equation (31a) computes the effects of treatment on the treated (TT) given by the difference between (a) and (c) in Table 6 which is the effect of participation in certified organic production systems on HDDS that in reality participated in organic certified production. The effect of the treatment to the untreated (TU) in equation (31b) is the difference between (d) and (b) in Table 6 and it computes the effect of participation in certified organic production systems on the households that in reality are noncertified producers. Equation (31c) computes the effect of base heterogeneity(BH_2) on HDDS of on households that are certified producers as the difference between (a) and (d) in Table 6 while equation (31d) computes the effect of base heterogeneity(BH_2) on HDDS of on households that are noncertified producers as the difference between (c) and (b) in Table 6. The difference between TT and TU computes the transitional heterogeneity(TH) on HDDS in Table 6 to gauge whether the effect of participation in certified organic production systems is larger or smaller on households that are engaged in certified organic production or households who were noncertified if they were to participate in certified organic production systems (Di Falco *et al.*, 2011; Akpalu and Normanyo, 2013).

Table 6: Conditional expectation, treatment and heterogeneity effects

	Decision stage		**Treatment effect**
Sub-populations	Certified	Noncertified	
Organic certified households	(a) $E(HDDS_{1i} \mid x_i, OC_i = 1)$	(c) $E(HDDS_{2i} \mid x_i, OC_i = 1)$	TT
Conventional households	(d) $E(HDDS_{1i} \mid x_i, OC_i = 0)$	(b) $E(HDDS_{2i} \mid x_i, OC_i = 0)$	TU
Heterogeneity effects	BH1	BH2	TH

Notes: (a) and (b) are the observed expected HDDS; (c) and (d) are the counterfactual HDDS; OC_i=1 if the household participated in certified organic production; $HDDS_{1i}$denotes household dietary diversity score if the household participated in certified organic production;$HDDS_{2i}$ denotes household dietary diversity score if the household did not participate in certified organic production; TT denotes the effect of the treatment (certification) on the treated (households that are certified); TU denotes the effect of the treatment (certification) on the untreated (noncertified households); BH_i denotes the effects of base heterogeneity for households that were certified (i=1) and did were not certified(i=2) and TH=TT-TU is the transitional heterogeneity.
Source: Di Falco *et al.* (2011) and Akpalu and Normanyo (2013).

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Descriptive statistics

4.1.1 Farmer characteristics

Table 7 presents results on level of education and gender of the household head. There was significant relationship between participation in certified organic farming and education level of the chief decision maker at 1% and 5% significant level in vegetable and honey producing households, respectively. In vegetable producing households, majority (37%) of household heads among conventional farmers had primary level of education while majority (49%) of certified organic producing household heads had secondary level of education. Over half (55%) of household heads in noncertified honey production system had primary level of education compared to about 49% in certified honey production system. Certified organic household heads had relatively higher levels of education than noncertified producers. Better educated farmers are likely to participate in evolving supply chains as they are innovative and relatively skilled to adjust to new production and market requirements (Rao and Qaim, 2011). Kersting and Wollni (2012) argue that highly educated farmers find it easy understanding and implementing food standards. Higher level of education empowers farmers in management of new technologies, including the associated risks and benefits that accompanies the technology (Tey *et al*., 2014).

Gender related constraints and imbalanced access to opportunities and productive resources has hindered agricultural growth in many developing countries (FAO, 2011). In terms of gender of the household head, 40% of certified organic producing households were female-headed compared to about 13% in conventional producing household in vegetable production system. Among organic honey producers, 40% of certified producers were female-headed compared to about 18% of the noncertified producers. Male-headed households, particularly in developing countries, have higher access to requisite resources and information that increases chances of them adopting new agricultural technologies (Odendo *et al*., 2009).

Table 7: Education level and gender of the household head (%)

Variable	Vegetable producers			Organic honey producers		
	Conventional	Certified	χ^2 value	Non-certified	Certified	χ^2 value
Education Level (%)						
None	23.77	3.08	46.088***	19.10	4.17	15.378**
Primary	36.89	7.69		55.06	48.96	
Secondary	27.05	49.23		17.98	31.25	
Tertiary	7.38	29.23		6.74	11.46	
University	4.92	10.77		1.12	4.17	
Gender (%)						
Female	13.11	40.00	17.091***	17.98	39.58	10.431**
Male	86.89	60.00		82.02	60.42	

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

Table 8 presents results on mean age of household head and household size. The mean age of household heads was lower for certified producers in both production systems. Households heads engaged in conventional vegetable production had about 50 years compared to 46 years for certified producers. Conversely, the mean age of household heads in honey production system was 56 years for noncertified producers and 50 years for certified producers, which was significantly different at 1 % level of significance. Younger farmers tend to be flexible in adapting to new market requirements, less risk averse and more innovative than older farmers (Rao and Qaim, 2011; Kersting and Wollni, 2012). Contrary, Wollni and Andersson (2014) found that older farmers were more likely to adopt organic farming in Honduras because of lower opportunity costs resulting in more willingness to undertake labour intensive technologies such as organic farming.

Table 8: Mean age of household head and household size

Variables	**Vegetable producers**			**Organic honey producers**		
	Conventional	Certified	*t*-value	Noncertified	Certified	*t*-value
Mean age (years)	49.98	45.92	1.981	55.89	49.71	3.773***
Mean household size (numbers)	4.39	4.80	-1.438	5.07	7.06	-6.622***

Note: *, ***=significant at 10% and 1% level, respectively.

Household size determines labour availability for farm production and is an important input in adoption of organic farming. This is on back drop that organic farming is a labour intensive technology (Offermann and Nieberg, 2000). There was significant difference at 1% significant level in mean household size among honey producers only (Table 8). Certified vegetable producers had on average 5 members while conventional vegetable producers had mean of 4 members. On the other hand, certified organic honey producers had mean of about 7 members compared to their counterparts with 5 members. In honey production systems, the probable explanation for households with larger family size being certified could be as a result of high food consumption expenditure. Thus, they would seek innovative ways to raise their income to meet their food and dietary and other pressing nonfood requirements like meeting education cost for their children, like participating in certified organic farming. Honey production is much less labour intensive compared to organic vegetable production. Battershill and Gilg (1997) argue that larger family size limits freedom in decision making and hence, personal wishes are overridden by family wishes affecting their participation in organic production initiatives.

Household head participation in off-farm activities result is presented in Figure 3. In vegetable producing households, 56% of household heads in conventional farming system engaged in off-farm income activities compared to 71% in certified organic vegetable producing households. In contrast, 44% of household heads were involved in off-farm activities among noncertified organic honey producers compared to 70% among the certified organic honey producers. Off-farm income is important in agricultural production as it improves farm liquidity through provision of supplementary income for purchase of farm inputs and payment of labour. It could also be an indicator of access to information due to exposure by the household head, which could enhance the adoption of organic farming. However, Wollni *et al*. (2010) argues that participation in off-farm activities constraints time available for adoption of labour intensive conservation agriculture technologies.

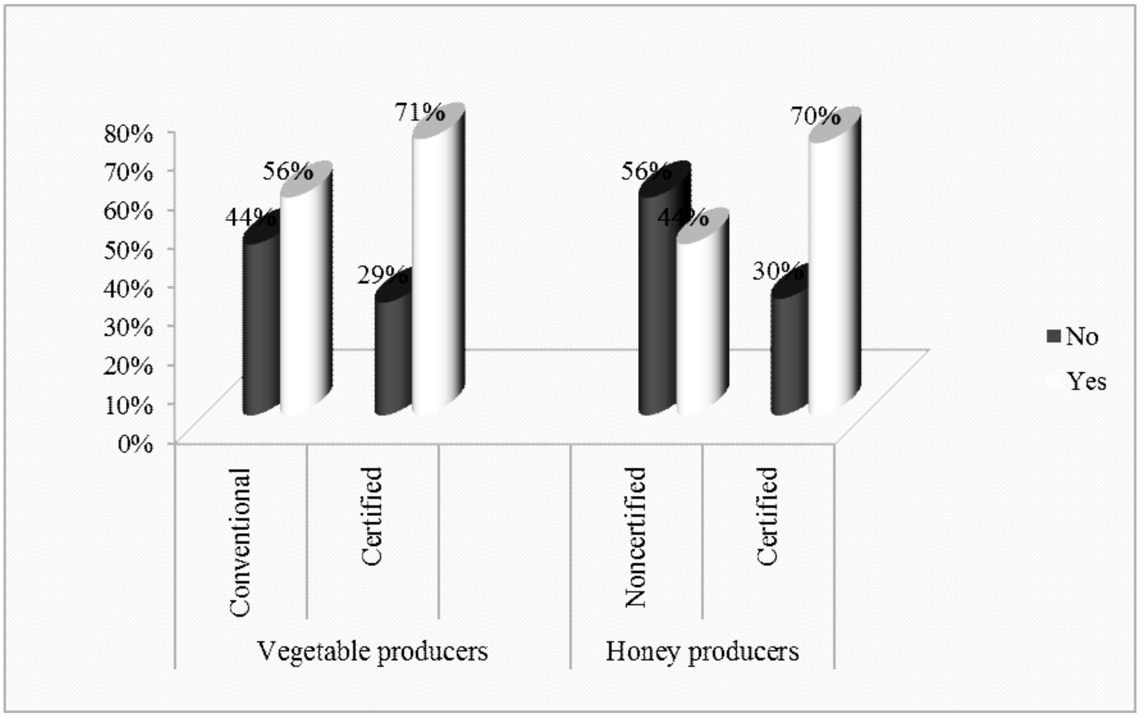

Figure 3: Household head participation in off-farm income activities (%)

4.1.2 Farm characteristics

Table 9 presents results for land size, agricultural assets and system of keeping livestock. Conventional vegetable producers had relatively larger agricultural land size of 0.89 acres compared to 0.71 acres. The smaller land size could be because of high level of land fragmentation in peri-urban areas compared to rural areas. Regarding honey producers, noncertified organic farmers had 3.5 acres of agricultural land while certified producers had 3.4 acres. Farmers with small land size could seek alternative ways of raising more income from smaller portions of their land like through certified organic production schemes. Handschuch *et al*. (2013) found positive correlation between GlobalGAP certification and land size, where smaller land holding households had lower chances of participating in high value market because of being uneconomical.

Concerning value of agricultural assets, conventional vegetable producers had asset value of KES 268916.00 compared to KES 268582.92 of certified organic producers. On the other hand, though not significantly different, non-certified organic honey producers had an asset value KES156, 401.01 compared to KES 186,868.96 of certified producers. Wealthier farmers are better placed in absorbing production and marketing risks as well as raising farm liquidity important in adoption food production standards (Kersting and Wollni, 2012). However, Handschuch *et al*. (2013) found insignificant effect of wealth in adoption of food standards among Chilean raspberry producers.

Table 9: Mean of farm characteristics

Variables	**Vegetable producers**			**Organic honey producers**		
	Conventional	Certified	*t*-value	Noncertified	Certified	*t*-value
Agricultural land size (Acres)	0.89	0.71	1.364	3.54	3.37	0.493
Agricultural assets(KES)	268916.00	268582.92	1.452	156401.01	186868.96	0.683
System of keeping livestock (%)			χ^2 value			χ^2 value
Closed	22.95	67.69	35.851***	2.20	-3.10	20.135**
Otherwise	77.05	32.31		97.80	96.90	

Note: *=significant at 10% level.

The system of livestock keeping could influence adoption of organic farming as farmers rely on animal manure in enhancing soil quality. There was significant relationship between participation in organic certified vegetable production system and system of keeping livestock in vegetable producing households at 1% significant level. About 68% of certified organic producers had closed system of keeping livestock compared to about 23% of conventional vegetable producers. The higher percentage of certified organic farmers could be attributed to ease and convenience in collection of manure used in vegetable farms in closed system as opposed to open system of keeping livestock. Majority (97%) of honey producers relied heavily on open livestock keeping system because of large land size in the expansive semi-arid area. Marenya and Barrett (2007) found livestock ownership as a vital factor influencing the adoption of sustainable land practices in Western Kenya.

4.1.3 Institutional and access characteristics

This subsection presents results on institutional characteristics. The key variables included farmers' contacts with extension service providers, number of trainings attended and market access, whose means are presented in Table 10. There was significant difference in the number of contacts with extension service providers at 5% and 10% significant level among vegetable producers and honey producers, respectively. In general, certified organic producers had higher number of contacts with extension service providers than their corresponding counterparts. Certified organic honey producers had twice the number of contacts with extension service providers than noncertified organic honey producers. Extension services provide means through which information is transmitted to farmers aimed at improving their farming skills. The higher number of contacts with extension service providers in certified organic production systems could be attributed to high market quality requirements for certified organic products, considering that certified organic farming is still a novel initiative to farmers.

Table 10: Mean of institutional and access characteristics

Variables	**Vegetable producers**			**Organic honey producers**		
	Conventional	Certified	*t*-value	Non-certified	Certified	*t*-value
Number of contacts with extension officers	0.91	3.15	-2.825**	0.82	1.66	-2.602*
Number of trainings received	6.44	7.21	-2.271**	10.47	12.95	-1.672*
Distance to the nearest market(Km)	3.47	3.26	0.510	13.19	9.77	2.760**

Note: *, ** =significant at 10% and 5% level, respectively.

Concerning number of trainings, farmers in certified organic production systems had more training than their corresponding counterparts and the trainings was significantly different at 5% and 10% significant level in vegetable and honey producing households, respectively. Conventional vegetable producers had about 6 trainings compared to 7 trainings of certified organic vegetable producers while noncertified organic honey producer farmers had 10 trainings compared 12 of certified organic honey producers. The high number of trainings among certified organic producers could be due to strict market regulation, hence the need for continuous training for quality purposes organized by community honey marketing groups. Further, the high number of trainings in honey production systems could be as a result of low level of education, which slows down information processing. The importance of information in influencing technology adoption among farmers has been emphasized in past studies (Barrett *et al*., 2011; Amare *et al.*, 2012; Rushemuka *et al*., 2014; Tey *et al*., 2014) in shaping perception and enhancing greater understanding of farming technologies.

Distance to the market is an important variable in commercializing smallholder agriculture because of access to farm inputs, information and also its effect on transportation costs (Fort and Ruben, 2009). Conventional and organic vegetable producers had mean distance to the nearest market of about 3 kilometres. Noncertified organic honey producers had mean distance to the nearest market of about 13 kilometres and certified organic honey producers had a mean of 10 kilometres. Previous studies have linked low probability of participation in organic agriculture to longer distance (remoteness) to markets, as it influences transaction costs and access to information (Amare *et al.*, 2012; Wollni and Andersson, 2014).

Social capital is critical asset in transforming structures and processes in the sutsainable livelihood framework (DfID, 1999). The study adapted the social capital dimensions as described by Grootaert (1999) and Yusuf (2008), which included density of membership, group heterogeneity index, meeting attendance index and level of decision making in groups (Table 11). Density of membership was measured by number of associations to which each household belongs and where they are active members.

Table 11: Mean of social capital dimensions

Variables	**Vegetable producers**			**Organic honey producers**		
	Conventional	Certified	*t*-value	Noncertified	Certified	*t*-value
Density of membership	1.49	1.71	-1.415	1.79	1.61	1.066
Group heterogeneity index	0.25	0.19	2.804***	0.10	0.15	-2.817***
Meeting attendance index	0.83	0.94	-1.422	0.57	0.71	-2.621***
Decision making index	0. 61	0.69	-1.711*	0.51	0.62	-2.827***

Note: *, ***=significant at 10% and 1% level, respectively.

In vegetable producing households, certified organic producers had mean density of membership of 1.71 compared to 1.49 of conventional farmers. In contrast, organic honey producers had relatively more density of membership than certified organic producers. Density of membership is an indicator of variety of information and knowledge sources, which could inform household participation in emerging supply chains like certified organic markets. Group heterogeneity index was computed from responses on diversity of group composition for all groups household members are active members. In each group, questions were asked if members were from same neighbourhood, occupation, kin group, economic status, religion, gender, education level and age group. There was significant difference in group heterogeneity index at 1% significant level between certified and noncertified farmers in vegetable and honey producing households. Conventional vegetable producers groups were 6% more heterogeneous than certified organic vegetable producers while certified honey producers were 5% more heterogeneous than organic honey producers. Lower level of heterogeneity in honey and vegetable production systems could be attributed to spatial differences, as vegetable farmers are in peri-urban area, which is a cosmopolitan area as opposed to the honey producers who are in rural areas. Group heterogeneity plays an important role on quality of information transmitted when farmers exchange information, experiences and knowledge in groups. Hence, having members with different background is an important consideration during group formation (Yusuf, 2008).

Household meeting attendance in groups is imperative as it demonstrates how active members are in group settings and also it is through attending meetings that members gain from information, experiences and knowledge exchanged (Yusuf, 2008). Household meeting attendance index was computed from a ratio involving number of scheduled meetings in 6 months and actual meetings members attended. In vegetable producing households, certified organic farmer attended on average 94% of all meetings compared to 83% in conventional farming system. Certified organic honey producers attended 71% of all scheduled meetings compared to 57% of organic honey producers and the result was significantly different at 1% significant level. Closer look reveals that the differences could be associated with higher number of groups noncertified households are engaged in compared to their corresponding counterparts which affects attendance of meetings.

Decision making index shows how active members participate in group activities. Further, it might influence member's participation in emerging agricultural product supply chains as it develops their own decision making skills. The decision making index was measured by ranked scale from 0 to 10 and later transformed to a range of between 0 to 100 before the average was computed for each household depending on the number of groups. There was significant difference between noncertified and certified farmers at 10% and 1% significant level in vegetable and honey producing households, respectively. In vegetable producing households, involvement of conventional producers in decision making in groups was 61% while that of certified producers was 69%. Similarly, organic honey producers' participation in decision making was 51% for noncertified producers compared to 62% of certified organic honey producers. Linking the results with those of meeting attendance index, it was observed that the more one attends meeting, the more they are likely to be involved in decision making. Social capital and networks reduce information asymmetry and transaction cost in making contracts and access to farm inputs including technical assistance. It also reorients community values, helping in reaching out to marginalized communities and influencing community acceptance of agricultural technologies (Marenya and Barrett, 2007; Teklewold *et al*., 2013; Bremer *et al*., 2014; Liu *et al*., 2014; Wollni and Andersson, 2014).

4.1.4 Selected agronomic practices in organic vegetable production systems

Maintaining and enhancing soil quality is a vital objective in organic production systems. Poor soil quality is characterized by low porosity, high bulk density, poor surface soil aggregation and slow water infiltration rates, which restrict agricultural productivity and increases soil erosion. Further, lower soil water holding capacity affects production systems resilience and stability (Evanylo *et al*., 2008; Giménez and Lanfranco, 2012; D'Hose *et al*., 2014). The soil and water conservation measures used by certified organic vegetable producers are presented in Figure 4.

Mulching was the most common practice used by about 68% of the farmers as soil/water conservation measure. Mulching increases water infiltration and water storage while reducing soil water evaporation losses and soil erosion, which promotes crop development leading to increased yield (Scopel *et al*., 2004; Ramakrishna *et al*., 2006). Further, mulching prevents weed growth by obstructing light penetration or by excluding certain light wavelengths needed from weed growth (Ossom *et al*., 2001). Conversely, mulching may lead to lower yield in crops by increasing the level of weed in farms through spread of more weed seeds (Whitten, 1999) or through failure to control weeds if mulch is unevenly applied (Henderson and Bishop, 2000). Other most used soil and water conservation measures were minimum tillage (50%), wind breaks by practicing agroforestry (45%) and water harvesting (41%) to be used during the dry seasons guaranteeing all year supply of certified organic produce to customers. Due to small land sizes, the least used measure was fallowing, used by about 5% of the farmers.

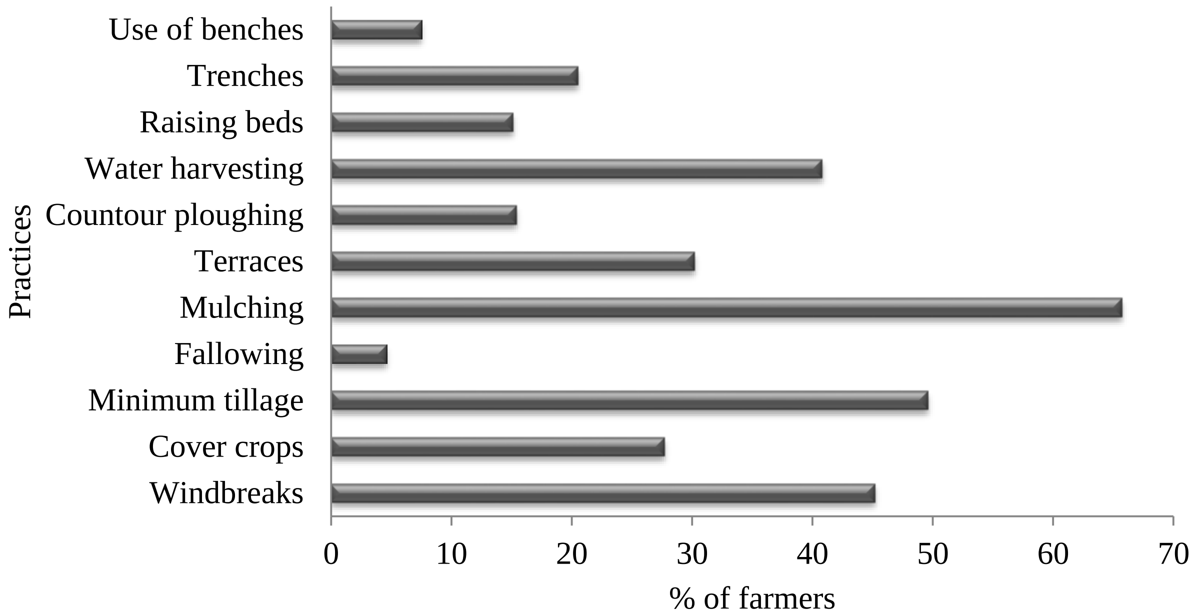

Figure 4: Soil and water conservation practices used in certified organic vegetable farms (%)

Declining soil fertility caused by poor agricultural activities is of global threat to environmental quality and sustainability of farmers' livelihood (Alliaume *et al*., 2014). Organic farming is based on soil organic matter management imperative in enhancing physical, biological and chemical soil properties (Evanylo *et al*., 2008; Oelofse *et al.*, 2011). The techniques used by farmers to enhance and maintain soil fertility in organic vegetable farms are presented in Figure 5. On-farm compost manure was used by all farmers, implying that it was the main technique used in soil fertility enhancement. During composting, microorganism degrades organic materials, mainly through aerobic processes under suitable conditions and time, resulting in stable and non-toxic crop-nutrient-rich end product free of pathogens (Evanylo *et al*., 2008; Ermolaev *et al*., 2014). However, the least used was organic mineral fertilizer (used by about 11% of the farmers). The low usage of purchased mineral fertilizer may be attributed to the relatively high acquisition cost and emphasis by promoters of organic agriculture to use the easily available local resources.

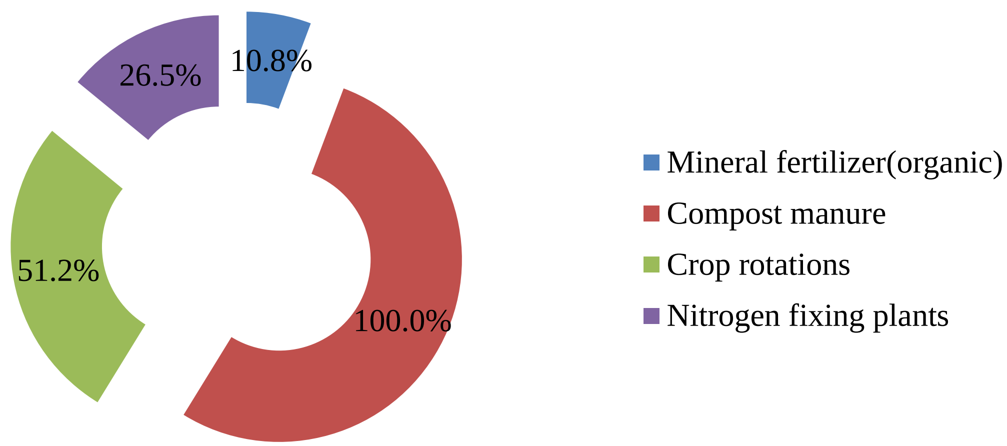

Figure 5: Soil/water fertility improvement practices used in certified organic vegetable farms (%)

In terms of weed management, Figure 6 presents the practices used by farmers in organic vegetable farms. Rather than spraying with chemicals, they practiced hoeing (92%), hand pulling (75%) and mulching (65%) as the most common techniques used in managing weeds. Walz (1999) had similar findings, where hand weeding (consisting of hoeing and hand pulling) was the common weed management practice among organic producers. This trend was attributed to relative availability of cheaper labour in developing countries. The least used methods in weed management were cover crops (27%) and slashing (5%). Some studies (Bond and Grundy, 2001; Turner *et al*., 2007) have cited weed management without use of herbicides as an impediment to conversion of some farmers to organic farming due to their ineffectiveness.

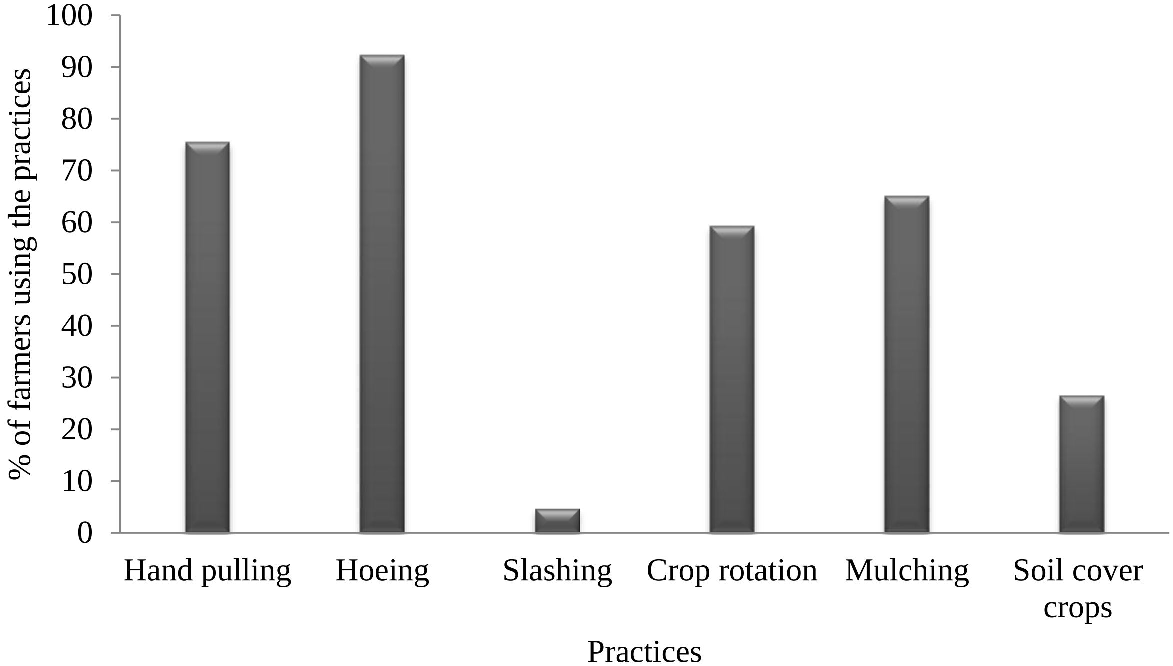

Figure 6: Weed management practices used in certified organic vegetable farms (%)

The practices used by certified organic vegetable farmers in pest and disease management are presented in Figure 7. Acceptable biodynamic preparation of manure by allowing proper composting of wastes ensures breakage of pest and disease cycles. This was reported by about 87% of the farmers as a technology used in managing pest and diseases. However, other common practices included diversified ecosystems (64%), crop rotation (51%) and manual elimination of infected crop or crop parts (42%). Organic pesticides were also used by about 20% of the farmers in cases of severe infestation but much of the efforts were put on preventive measures. Oelofse *et al.* (2011) notes that pest and disease management was a critical problem facing organic farmers, limiting conversion to organic farming. Further, World Bank (2005) noted that ineffective results of integrated pest management practices in developing countries is due to failure of the promoters in addressing broader spectrum of social, economic and agronomical impediments that limit farmer’s knowledge on the technologies.

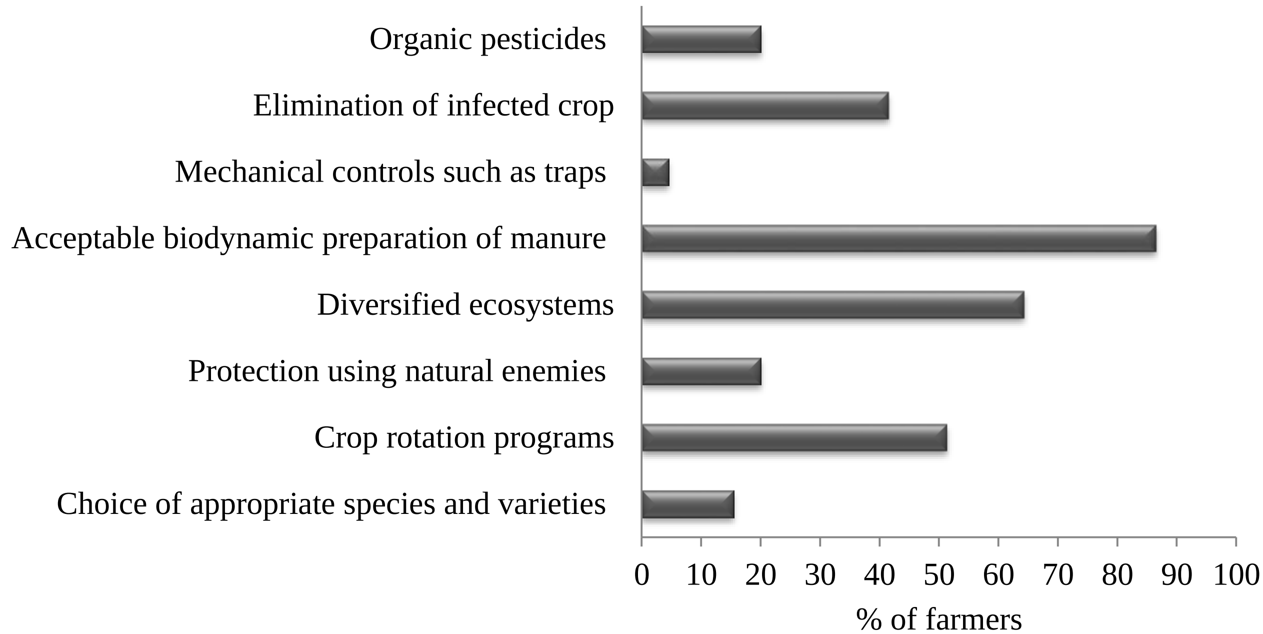

Figure 7: Pest and disease management used in certified organic vegetable farms (%)

4.1.5 Level of WEIA

Descriptive statistics of dimensions and the overall level of WEIA are presented in Table 12. In conventional and certified organic vegetable producing households, significant differences were observed in the level of women empowerment in resources, leadership and time dimensions as well as in the overall index. Conversely, there was significant difference in women empowerment in production, leadership and time dimensions among noncertified and certified honey producing households. Vegetable producers had relatively higher levels of empowerment in production (39%), resources (41%) and leadership (40%).

On the contrary, women in honey producing households had relatively higher overall level of empowerment in production (40%), leadership (36%) and time (42%) dimensions. Men were at realm in resource and income dimensions. This confirmed the opinion raised by women during focus group discussion that men were willing to engage women in decision making more in dimensions which they consider as less important, particularly where small amount of money is involved. On the overall index of empowerment, women in honey producing households had 35 per cent involvement in decision making compared to 38 per cent in vegetable producing households. This could be attributed to spatial differences in socio-economic and cultural constraints in the two production system.

Table 12: Mean values for dimensions of WEIA (0-100%)

Dimensions	Vegetable producers			Organic honey producers		
	Noncertified	Certified	Overall	Noncertified	Certified	Overall
Production	40.52	39.15	39.46	37.23	41.97**	39.63
	(19.21)	(23.12)	(20.32)	(18.28)	(22.13)	(18.92)
Income	35.21	36.13	35.86	27.23	27.78	27.25
	(25.23)	(19.35)	(21.10)	(21.01)	(20.02)	(21.05)
Resources	38.35	42.91**	40.56	30.96	30.31	30.85
	(24.21)	(18.23)	(19.46)	(20.99)	(21.11)	(20.96)
Leadership	37.29	42.28***	39.72	36.34	42.23***	37.54
	(41.19)	(42.84)	(44.01)	(29.97)	(39.88)	(36.17)
Time	36.71	31.28***	34.83	39.11	43.21**	41.81
	(41.23)	(39.54)	(40.82)	(27.36)	(28.29)	(30.82)
Overall women empowerment index	36.41	41.12**	38.08	35.43	37.51	35.41
	(16.17)	(28.36)	(25.36)	(23.28)	(32.19)	(23.26)

Notes: Figures in parenthesis are standard deviations. ** and *** indicates that the mean values are significantly different from the noncertified producing households in each product type at 5 per cent and 1 per cent level respectively.

4.1.6 Household dietary diversity

HDDS was measured using FAO (2010) guidelines, which involved 24 hour recall period in 16 food groups. This was further recoded to 12 food groups as recommended by FAO (2010) as shown in Table 13, which also includes descriptive statistics for different food groups. From the results, 99.5% and 98.4% of vegetable and honey producing households respectively consumed cereals. Vegetables were consumed by 92% of households in vegetable production systems compared to 74% of households engaged in honey production. Being in rural areas and in semiarid area, honey producers relatively consumed less fruits, meat, eggs, milk and milk products and oils/fats as compared to their counterparts. Fish and sea food were not consumed at all among honey producers probably because of its physical and economic inaccessibility by households and also fish and fish products did not form part of their cultural diet. Honey producers being in predominantly pulses, legumes and nuts producing zone, they exhibited higher consumption in pulses, legumes and nuts as compared to their vegetable producers. Ruel

(2003) noted that dietary diversity is severe in developing countries, especially among poor households, as their basic diets are predominantly starchy staple foods with minimal fresh fruits.

Table 13: Dietary intake of households by production system (%)

Food groups (%)	Vegetable producers			Organic honey producers		
	Conventional	Certified Organic	Total	Noncertified	Certified	Total
Cereals	100.0	98.5	99.5	98.9	97.9	98.4
White roots and tubers	57.4	53.8	56.1	11.2	2.1	6.5
Vegetables*	92.6	90.8	92.0	67.4	80.2	74.1
Fruits**	25.4	35.4	28.9	15.7	11.5	13.5
Meat***	27.0	35.4	29.9	4.5	4.2	4.3
Eggs	10.7	20.0	13.9	4.5	2.1	3.2
Fish and seafood	8.2	12.3	9.6	0.0	0.0	0.0
Pulses, legumes and nuts	58.2	67.7	61.5	92.1	93.8	93.0
Milk and milk products	93.4	95.4	94.1	85.4	92.7	89.2
Oils and fats	99.2	98.5	98.9	94.4	96.9	95.7
Sweets and sugar	91.8	90.8	91.4	88.8	93.8	91.4
Spices, condiments and beverages	90.2	93.8	91.4	97.8	96.9	97.3

Notes: *The food group of vegetable is made up of vitamin A rich vegetables and tubers, dark green leafy vegetables including and other edible vegetables. **The group of fruit is made up of vitamin A rich fruits and other fruits. ***The group of meat is made up of organ meat and flesh meat.

4.2 Determinants of participation in certified organic farming

Table 14 presents maximum likelihood estimates of Probit models regression results used in predicting individual propensity scores and to determine farm and farmer socio-economic characteristics that influence participation in certified organic production among vegetable and honey producers. The models reported a number of variables significantly influencing participation in organic certification schemes. Younger farmers were more likely to participate in certified organic farming in vegetable and honey production systems. Younger farmers have tendency of being innovative, risk averse and having greater flexibility, important in changing their farming practices to meet new market requirements. Kersting and Wollni (2012) found similar result, where younger fruit and vegetable farmers had higher probability of adopting GlobalGap standards in Thailand. In contrast, Nhemachena and Hassan (2007) found out that older farmers had tendency of adopting new technologies because of high number of farming experience, capital accumulation and larger household size.

Table 14: Determinants for participation in certified organic farming (probit estimates)

Variable	Vegetable producers		Honey Producers	
	Coeff.	Std. Err.	Coeff.	Std. Err.
Head age	-0.032**	0.027	-0.087***	0.018
Gender head	-1.801	0.663	-0.674	0.314
Education head	0.390*	0.197	0.377***	0.198
Household size	0.180	0.150	0.383*	0.101
Off-farm employment	0.714**	0.400	0.102	0.339
Log of agricultural assets	0.980	0.321	0.174	0.250
Farm size	-0.241	0.185	0.052	0.211
Information sources				
Farmer-to-farmer extension	0.019*	0.590	0.087***	0.483
Government extension	- 0.018	0.196	0.120**	0.103
Non-governmental extension	0.057***	0.248	0.526**	0.145
Print and visual media	0.039	0.090	-0.044	0.090
Number of trainings	0.216***	0.412	-0.268	0.362
Market distance	-0.077	0.021	-0.091**	0.035
Credit access	0.532	0.414	0.595	0.584
Social capital variables				
Density of membership	0.058***	0.187	-0.050	0.185
Meeting attendance	0.338	0.413	1.487**	0.546
Group heterogeneity	0.111*	1.820	0.874**	0.174
Decision index	0.186**	0.149	0.306**	0.072
Trust	-0.093	0.028	0.321	0.104
System of livestock keeping	1.438**	0.418	-	-
Constant	-4.321**	3.471	-5.247*	3.100

Note: *, **, ***=significant at 10%, 5% and 1% level, respectively.

Better educated farmers were more likely to participate in certified organic production system in vegetable and honey production systems. Education is important in changing perception and shaping farmers ability to be innovative critical during conversion to new production and market requirements. Nunes *et al*. (2014) found that higher education is critical in changing farmers perceptions towards competitiveness and environments practices in Brazil. Larger household size influenced positively the likelihood of participating in certified organic honey production. This was interesting, since honey production is far much less labour intensive unlike organic vegetable production. However, larger households have high food and non-food expenditures. Hence, such households would be willing to undertake any new venture as long as it can put extra plate of food on the table; considering the region is prone to food insecurity.

Household head participation in off-farm activities increased the likelihood of participating in certified organic farming only in vegetable production system. Income from off-farm activities supplements farming income to meet high production costs (particularly labour costs) and investment costs associated with certified organic vegetable farming. Participation in off-farm activities could also be an indicator of access to information because of interaction with others, which could influence farming decisions. Rao and Qaim (2011) found also that income from off-farm activities could be used to finance farm investment required for farmers' participation in high value markets, in their case supplying vegetables to supermarkets, especially when farmers have limited access to credit. Having more assets value also increased the probability of participating in organic certified vegetable farming. Since vegetable organic certification scheme is still developing, assets could be used to cushion participating households from production and marketing risks by raising farm liquidity.

Access to information sources positively increased the probability of households to participate in certified vegetable and honey production. Information from government extension agents influenced significantly participation of honey producer in certified organic production only while farmer to farmer and non-governmental extension information sources influenced participation in certified production in both production systems. A plausible explanation could be that farmer to farmer extension has high convincing power as farmers can easily observe what their colleagues are practicing on their farms. Farmers also may pass information to each other in a language that is easy to understand, which furthers their understanding of technologies. Conversely, information from non-governmental extension officers use motivational factors to influence farmers to participate in certified production systems. Effective agricultural information sources is important in shaping famers' perception, attitude and knowledge on agricultural innovations. This enhances farmers' adoption of agricultural innovations.

Institutional support in terms of more frequent trainings significantly influenced the probability of participation in certified organic vegetable production. This could be ascribed to diverse number of vegetable crops that are grown by farmers motivated to enhance biodiversity and crop diversification of bio intensive organic products in the relatively smaller pieces of land in peri-urban area. Further, being in peri-urban areas where pollution is rampant and certified organic farming being knowledge intensive, there is need for extra trainings in order to comply with tight market standards set by the certifier. Karki *et al.* (2011) observed similar finding in conversion to organic tea in Nepal, where more frequent trainings was deemed important, particularly in cases where the target population has low level of education. Longer distance to the nearest honey market limited farmers' likelihood of participation in certified organic honey production. This is explained by the nature of the study area, which is an expansive area with dilapidated roads, encumbering delivery of harvested honey to collection centres. Admittedly, distant farmers tend to sell their produce to exploitative intermediaries at lower prices. Similar finding was reported by Amare *et al.* (2012) and Wollni and Andersson (2014), where longer distance (remoteness) to markets discouraged adoption of organic farming, as it effects transportation cost and access to information.

Some social capital dimensions as described by Grootaert (1999) significantly influenced the probability of participating in organic certified production. Households with many members in groups (measured by density of membership) were more likely to participate in certified organic vegetable farming. This could be linked with group heterogeneity index descriptive statistics (Table 11), where farmers in vegetable production areas had less membership in groups but which are more heterogeneous and with higher meeting attendance in their groups than honey producers. Higher density of membership increases the variety as well as quality of information and knowledge sources that could inform household participation in emerging supply chains like certified organic production.

Higher group heterogeneity and decision making index increased significantly the likelihood of farmer participation in certified organic vegetable and honey production system. Group heterogeneity plays focal role during group meetings as it determines quality and variety of information, experiences and knowledge to be exchanged among group members. Hence, having members with different background is important during group formation. Meeting attendance by group members is imperative as it indicates how active members are in group settings. It is through attending meetings that members exchange information, experience and knowledge important in shaping their farming decisions. Involvement of group members in decision making also enhances their decision making skills and creates ownership of decisions, which may facilitate technology adoption. Teklewold *et al.* (2013) found that social capital and networks are important in influencing diffusion of most sustainable agricultural practices in Ethiopia as they enhance exchange of information, facilitates timely input access including credit. Finally, having closed system of rearing animals increased the likelihood of participation in certified organic vegetable farming. Livestock is important in organic farming as it is the main source of manure critical in enhancing soil fertility and nutrient management in organic production systems. Therefore, having closed system makes collection and transportation of manure to vegetable farms easier lowering labour costs involved. Kassie *et al*. (2013) also found that household livestock ownership enhanced the adoption of conservation agriculture technologies.

4.3 Effects of organic certification on household income under the assumption of homogeneity

To demonstrate the homogenous effect of certification on logged household income, equation (32) and (33) were estimated as;

$$Y_i = \alpha + \beta C_i \qquad (32)$$

and

$$Y_i = \alpha + \beta C_i + \lambda pscore$$

(33)

In equation (32), an ordinary least square regression of logged income (Y_i) as the dependent variable and binary variable of certification C_i as independent variable. The β coefficient is interpreted as the effect of organic certification. Equation (33) is an extension of equation (32) to include the propensity scores (pscore) in order to control for self-selection bias (Brand and Xie; 2010; Mutuc *et al.*, 2013). Table 15 presents results of the two equations.

Table 15: Homogeneous organic certification effects of on household income

Variable	Vegetable producers		Honey producers	
	Coefficient	Standard error	Coefficient	Standard error
$Y_i = \alpha + \beta C_i$				
Certified organic participation	0.115***	0.019	0.324***	0.016
Constant	11.035***	0.011	10.074***	0.012
$Y_i = \alpha + \beta C_i + \lambda pscore$				
Certified organic participation	0.091***	0.037	0.309***	0.026
Propensity score	-0.032	0.044	-0.021	0.033
Constant	11.038***	0.012	10.078***	0.013

Note: *** correspond to 1% level of significance.

The β coefficients were positive and significant at 1% in both production systems. If the differences in background characteristics are not controlled, organic certification increases household income by 12% and 32% in vegetable and honey producing households, respectively. In contrast, if the background characteristics are controlled by including the propensity scores in the regression, certified organic farming increases household income by about 9% and 30.9% in vegetable and honey producing households, respectively. However, the major weakness these estimations are that they conceal variability of organic certification effects on household income between subpopulation that is of interest in this study.

4.4 Heterogeneous organic certification effects on household income

To determine the heterogeneity in effects of certification on household income, stratification multilevel and matching-smoothing approaches were used. Beginning with stratification multilevel methodology, the method was an estimation of heterogeneous effect of organic certification on logged household income using propensity scores by Becker and Ichino (2002). It starts by constructing balanced propensity score strata before estimating average organic certification effect within each stratum. Using variance weighted least squares regression, a linear trend is evaluated across different strata based on strata specific certification effects before linear trend is displayed graphically (Brand and Xie, 2010; Mutuc *et al.*, 2013). Results for level 1 and level 2 slopes are reported in Table 16 and are plotted in Figure 8(a) and (b) for vegetable and honey producers, respectively.

Table 16: Heterogeneous organic certification effects on logged household income

Level-1 Slopes	Vegetable producers		Honey producers	
	Coefficient	Standard Errors	Coefficient	Standard Errors
1 (.00-.20)	0.064	0.083	0.263***	0.034
2 (.20-.40)	0.102	0.067	0.388***	0.036
3 (.40-.60)	0.039	0.059	0.369***	0.040
4 (.60-.80)	0.213***	0.060	0.350***	0.052
5 (.80-1.00)	0.138**	0.142	0.314***	0.088
Level-2 slope	0.037	0.028	0.022	0.016

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

Level 1 slope are point estimates of stratum specific effects of organic certification on household income (which are plotted in Figure 8). In vegetable production system, farmers with higher propensity scores to participate in organic certification (in strata 4 and 5) significantly benefit most. A unit change in stratum rank was associated with about 4% increase in logged household income. This implies that households with higher propensity to participate in certified organic vegetable production experience higher household income. However, in honey production system, positive effect organic certification is throughout the stratum rank at 1% significance level. The sub-groups of producers who benefited most were somewhat in the mid strata (strata 2 and 3). A unit change in stratum rank was associated with about 2% increase in logged household income. These findings demonstrate heterogeneous effects of certified organic production on household income. The differences in the two production systems might be attributed to program design. In vegetable production system, farmers self-select themselves in certified organic production. In contrast, farmers self-select themselves but they further undergo thorough screening before enrolling in certified organic honey production program to ensure the poor farmers are encouraged to participate in the emerging high value production system.

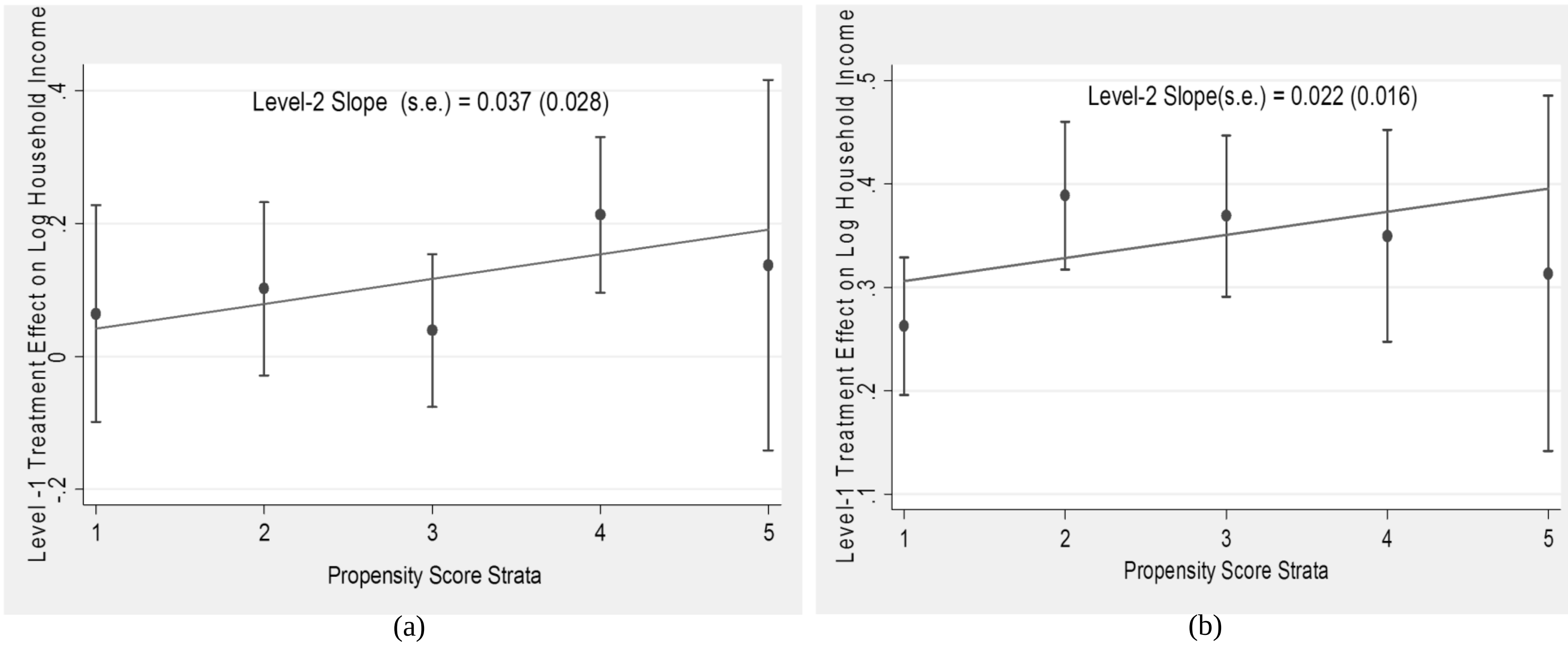

Figure 8: Stratified organic certification effect on household income

To explore the observable farm and farmer characteristics that inform heterogeneity in organic certification effects on household income, the mean values of the covariates are presented in Table 17 and 18 for vegetable and honey production system, respectively. In vegetable production system, there was an increase in level of education and participation in off-farm income by the household head, number of agricultural trainings received by the household, value of agricultural assets and social capital variables as propensity score increased. However, with increased propensity scores, the age of farmers decreased, which again confirms the earlier result on the determinants of participation in organic certified vegetable production. This provides evidence that the socially and economically advantaged farmers benefit most because of shortfalls in targeting in the scheme.

Table 17: Mean values for socioeconomic and institutional characteristics by propensity score strata in vegetable production system

Variables	Stratum 1 [.00-.20]		Stratum 2 [.20-.40]		Stratum 3 [.40-.60]		Stratum 4 [.60-.80]		Stratum 5 [.80-1.00]	
	Conv.[a]	Cert. Org.[b]	Conv.[a]	Cert. org[b]	Conv.[a]	Cert. Org.[b]	Conv.[a]	Cert. Org.[b]	Conv.[a]	Cert. Org.[b]
Education level	2.62	2.89	2.50	2.98	3.38	3.79	3.56	3.74	3.87	3.54
Gender	0.84	0.68	0.87	0.62	0.88	0.60	0.86	0.56	0.89	0.55
Head age	62.23	57.96	56.65	50.28	50.98	46.25	48.28	40.28	43.25	41.36
Household size	5.02	4.89	4.75	4.68	4.28	4.50	4.56	5.12	4.42	5.06
Off- farm income participation	0.41	0.56	0.56	0.63	0.74	0.86	0.45	0.72	0.54	0.69
Agricultural land size	1.12	0.89	0.95	0.72	0.87	0.75	0.78	0.68	0.82	0.67
Agricultural assets (‘000)	252.25	265.21	254.36	258.89	263.23	268.79	273.85	265.32	298.25	279.91
System of keeping livestock	0.18	0.42	0.21	0.54	0.29	0.69	0.24	0.85	0.21	0.69
Number of extension	0.89	3.92	1.23	3.25	1.09	2.89	0.86	2.96	0.91	2.76
Number of trainings	6.38	5.23	6.69	6.39	7.05	7.28	6.32	7.96	6.25	7.53
Market distance	3.82	3.28	3.63	2.78	3.04	3.96	3.25	3.28	3.35	2.92
Density of membership	1.39	1.48	1.38	1.49	1.47	1.49	1.59	2.89	1.97	1.81
Group heterogeneity	0.12	0.18	0.19	0.18	0.14	0.19	0.32	0.22	0.37	0.19
Meeting attendance	0.85	0.94	0.92	0.98	0.83	0.91	0.81	0.88	0.79	0.94
Decision index	0.54	0.62	0.56	0.58	0.69	0.67	0.62	0.78	0.60	0.72
Trust	0.62	0.54	0.58	0.58	0.50	0.60	0.54	0.68	0.56	0.66

Notes: a. Conventional vegetable producers. b. Certified organic vegetable producers.

Table 18: Mean values for socioeconomic and institutional characteristics by propensity score strata in honey production system

Variables	Stratum 1 [.00-.20]		Stratum 2 [.20-.40]		Stratum 3 [.40-.60]		Stratum 4 [.60-.80]		Stratum 5 [.80-1.00]	
	Non-cert.[a]	Cert.[b]	Non-cert.[a]	Cert.[b]	Non-cert.[a]	Cert.[b]	Non-cert.[a]	Cert.[b]	Non-cert.[a]	Cert.[b]
Education level	1.45	1.85	1.56	1.78	1.98	2.38	2.48	2.89	2.97	2.99
Gender	0.87	0.61	0.84	0.68	0.89	0.58	0.74	0.56	0.81	0.61
Head age	68.23	58.25	55.81	52.24	59.84	49.97	50.39	46.93	46.13	40.89
Household size	5.54	6.25	5.02	5.56	5.25	7.28	5.23	7.71	4.92	7.23
Off- farm income participation	0.38	0.78	0.41	0.65	0.46	0.62	0.53	0.71	0.42	0.69
Agricultural land size	3.82	3.25	3.25	3.85	3.75	3.21	3.52	3.02	3.45	3.12
Agricultural assets (‘000)	147.21	152.54	145.23	187.39	150.36	181.23	174.23	187.39	162.93	198.21
Number of extension	0.83	1.32	1.82	0.65	0.36	1.42	0.85	1.39	0.85	1.88
Number of trainings	9.36	11.28	12.36	13.98	13.23	12.23	9.23	12.97	7.21	13.45
Market distance	12.32	12.23	15.25	9.29	10.23	9.12	9.28	8.29	8.03	7.28
Density of membership	1.89	1.82	1.82	1.60	1.76	1.52	1.75	1.56	1.76	1.54
Group heterogeneity	0.08	0.11	0.82	14.85	9.24	14.86	10.23	15.99	10.51	15.88
Meeting attendance	0.49	0.69	0.58	0.75	0.56	0.74	0.62	0.65	0.61	0.85
Decision index	0.45	0.56	0.49	0.58	0.64	0.66	0.55	0.64	0.45	0.69
Trust	0.54	0.61	0.63	0.68	0.68	0.68	0.59	0.70	0.66	0.70

Notes: a. Non-certified organic honey producers. b. Certified organic honey producers.

Exclusion of farmers who are economically and socially disadvantaged from participation in this emerging supply chain may lead to further marginalization beating the logic of program being pro-poor. However, because of program failure in screening farmers during enrolment in organic certification program, the farmers self-select themselves by "sorting out the gains" of them participating in certified organic vegetable production. The relatively high production and investment costs in certified organic vegetable production costs compared to certified organic honey could also play a role in limiting the enrolment of poor farmers in the scheme. These findings repudiates program planners' pro-poor objective of increasing household income of socially and economically disadvantaged farmers through participation in certified organic production system chain. Subervie and Vagneron (2013) found that GlobalGap certification benefited only the "chosen few" among lychee farmers in Madagascar.

In contrast, though farmers in lower strata in honey production system are socially and economically disadvantaged (Table 18), they benefit from organic certification program. Certified organic honey production system being low input investment compared to organic vegetable production systems enhances the ability of poor farmers to participate in such low cost schemes. Screening of farmers during enrolment and initial proper targeting with the help of community leaders in the program ensures that its pro-poor objective is achieved while enhancing social equity in society.

The matching-smoothing method of estimating heterogeneous treatment effects was estimated to overcome the limitations of stratified multilevel approach of estimating heterogeneous treatment effects. The weaknesses include that of homogeneity assumption within strata and assumption that linear trend exists in the pattern of heterogeneity (Xie *et al*., 2012; Mutuc *et al.* 2013). The matching-smoothing approach results are presented in Figure 9 (a) and (b) for vegetable and honey production system, respectively. The local polynomial regression was used as smoothing device (Epanechnikov kernel, degree 2, bandwidth 0.1) and the shaded region represents 95% confidence interval.

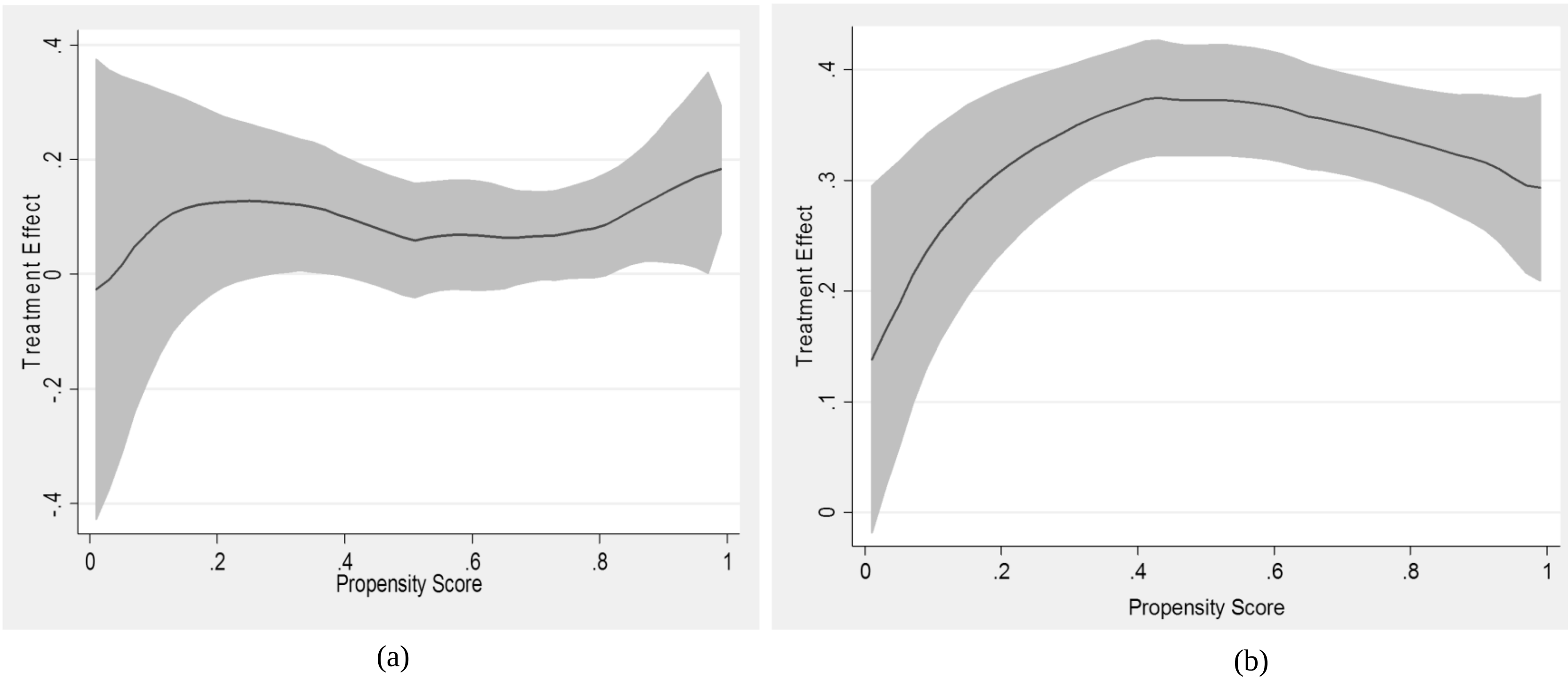

Figure 9: Matched differences in certification effect on logged household income

The result complement findings using stratified multilevel approach and provide more articulated picture of who benefits most from participation in certified organic farming. In vegetable production system, there was drastic increase in logged household income in strata 1 and it then flattens before increasing in strata 4 and 5. The implication is that though farmers in lower stratum experience increase in household income with increased propensity scores, the ones who benefit most are those on higher stratum (strata 4 and 5). In contrast, honey producers reported very interesting results. There was a far-reaching increase in household income in the lower strata (1 and 2) before flattening in strata 3 and finally declining gradually in strata 4 and 5. Farmers in strata 2 and 3 had experienced more effect in household income hence, benefiting most from the scheme. This finding could be attributed to proper targeting of participants in the scheme, which has not only increased household income across all strata but has fostered social equity in the society.

To check robustness of the findings, Altonji *et al*. (2005) approach was used as described in sub-section 3.5.1 to investigate potential bias in effect of organic certification due to selection on unobservables. The τ (which is the ratio of estimated ATT parameter to estimated selection on unobservables) was 2.2 and 1.8 for vegetable and honey production systems, respectively. Since τ in both production systems are substantially greater than 1.0, it indicates that selection on unobservables may not be a big issue in the analysis in vegetable and honey production systems.

4.5 Determinants of multidimensional poverty status

To determine the role of certified organic production on peri-urban and rural poverty reduction, the endogenous switching probit model was used for analysis. Theoretically, endogenous switching probit model is identified by functional form (Lokshin and Sajaia, 2011; Gregory and Coleman-Jensen, 2013). Hence, the study used exclusion restriction methodology to improve on identification, where z_i in equations 1(a) and (b) contained at least one variable not in X_i, in equations 1(a) and (b) (Wooldridge, 2010; Lokshin and Sajaia, 2011). The study used agricultural information sources as used in previous studies (Di Falco *et al*., 2011; Asfaw *et al*., 2012; Negash and Swinnen, 2013) as instruments. The type of agricultural information sources included were farmer-to-farmer, government extension officers, non-governmental organization extension officers and print and visual media. Table 19 presents falsification tests that indicated sources of agricultural information as valid instruments. Further diagnostic tests were conducted on validity of the instruments. Sargan's test was used to test the correlation between the instruments excluded and error terms (Sargan, 1958). Sargan test was $\Pr > \chi^2(1) = 0.427$ in vegetable production system and $\Pr > \chi^2(1) = 0.312$ in honey production system affirming that the excluded instruments were uncorrelated with the error terms.

Table 19: Tests on the validity of selected instruments

Variable	First stage				Second stage			
	Vegetable producers		Honey producers		Conventional vegetable producers		Noncertified honey producers	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Farmer-to-farmer extension	0.019*	0.590	0.087***	0.483	0.033	0.045	-0.052	0.107
Government extension	0.018	0.196	0.120**	0.103	0.064	0.038	-0.110	0.066
Non-governmental extension	0.057***	0.248	0.526**	0.145	-0.044	0.043	0.045	0.035
Print and visual media	0.039	0.090	0.044	0.090	0.005**	0.059	-0.014**	0.038
Constant	-4.321**	3.471	-5.247*	3.100	-4.181**	0.797	8.071*	0.102
Wald test	27.99***		34.11***					

Note: *, **, ***=significant at 10%, 5% and 1% level, respectively

Further, Wald test (lower panel of table 19) was used to test the joint significance of the instruments excluded helping in testing the hypothesis of weak instruments. Wald test was $\chi^2(2) = 34.11$ in vegetable production system and $\chi^2(2) = 27.99$ in honey production system. Hence, the hypothesis of weak instruments was rejected. The determinants of household multidimensional poverty status results are reported in Table 20. The independent variables were selected from past studies on determinants of poverty (Carter and Barrett, 2006; Krishna and Shariff, 2011; Batana, 2013). At the lower panel of Table 20, ρ_0 and ρ_1 are negative for nonparticipants and participants in vegetable and honey certified organic production system. This was an indication that households which were less likely to participate in organic certified production systems were more likely to be multidimensional poor, due to unobservable household characteristics. The likelihood-ratio tests for the joint independence of the equations were not significant in both production systems, validating the use of the switching probit model as opposed to the bivariate probit model.

Table 20: Determinants of poverty status

Variable	Vegetable producers				Organic honey producers			
	Conventional		Certified organic		Noncertified		Certified	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Head age	-0.014**	0.013	-0.024***	0.087	-0.045	0.052	-0.022**	0.121
Gender head	-0.640	0.418	0.861	0.382	0.512	0.448	-0.251	0.853
Off-farm employment	-0.065*	0.173	-0.176**	0.241	-0.162***	0.427	-0.385**	0.247
Household size	0.261	0.110	-0.442	0.141	0.073***	0.111	0.181***	0.632
Farm size	-0.057***	0.824	-0.023**	0.054	0.352	0.321	0.258	0.182
Credit access	0.044	0.164	-0.053**	0.179	0.505	0.216	-0.177	0.283
Log of agricultural assets	0.156	1.450	-0.164	0.532	-0.088	0.285	-0.128	0.894
Number of trainings	0.057	0.039	-0.044	0.043	0.045	0.035	-0.033	0.023
Market distance	-0.265	0.415	-0.288	0.639	-0.040**	0.017	-0.001*	0.074
Social capital variables								
Density of membership	-0.298	0.384	-0.173	0.217	-0.437**	0.832	0.001*	0.211
Meeting attendance index	-0.849	0.251	-1.325**	0.615	-1.471***	1.949	0.369***	0.524
Group heterogeneity index	-0.216***	0.510	-0.732**	0.761	-0.214	0.361	-0.428	0.392
Decision making index	0.011**	0.425	0.023	0.491	-0.287	0.936	-0.285	0.299
Trust among group members	-0.255	0.782	-2.221	0.462	-2.358	1.280	-0.657	0.710
System of livestock keeping	-0.024*	0.151	0.050	0.010				
Constant	-4.333**	0.825	-3.254**	2.252	7.987*	0.090	-5.472	3.628
ρ_0	-0.814	0.973			-0.449	0.622		
ρ_1			-0.239	0.994			-0.153	0.191
Lr. test for indep. Eqns. (rho1=rho0)	Chi2(2)=1.16 prob>chi2=0.442				Chi2(2)=1.81 prob>chi2=0.371			

Notes:*, **, ***=significant at 10%, 5% and 1% level respectively. a. Dummy variables representing the household agricultural asset quintile, with third quintile being the comparison group.

Age of the household head negatively influenced likelihood of household being poor in all four categories, except among noncertified organic honey producers. Older household decision makers had lower likelihood of being poor possibly because of the amassed wealth over time enabling them to make more human development investments. Further, the pseudo characteristic of age being an indicator of farming experience, older household head could use their experience as household agricultural executives in the uncertain world of farming to get better yields and hence more income, which is reinvested for purposes of human development. Krishna and Shariff (2011) also found that older household heads (above 40 years) in India had higher probability of escaping poverty and less likely of falling into poverty.

Participation of household head in off-farm income generating activities reduced the likelihood of household being multidimensional poor in all the four categories. The finding demonstrates the vital role of off-farm activities in enhancing household income diversification due to the uncertainty and risks facing agriculture in most developing countries. Additionally, participation in off-farm activities could expose household decision makers and get more information on how to build their household human development indicators. This result is in line with past studies by Shete (2010) and Krishna and Shariff (2011), where participation in off-farm increased the probability of escaping poverty in Ethiopia and India, respectively. Families with larger household size had higher probability of being poor in honey production systems. Households with larger family size may face difficulty in financing and building their human development indicators, as most of household income is spent on food expenditure. Households with higher larger family size are associated with higher probability of poverty in previous studies (Shete, 2010; Arif and Farooq, 2012), as it places additional burden on their assets and other resources.

Larger agricultural land size decreased the likelihood of being poor in vegetable producing households only. In vegetable producing households, land is relatively scarce due to their location in peri-urban compared to rural honey producers. Therefore, farmers with larger land size are more likely to produce more leading to higher income, which facilitates them in building their human development indicators. This is opposed to the semi-arid honey producers, who have relatively bigger land size, purely rain fed and the production system is faced by relatively higher production and investment uncertainty. Previous studies (Shete, 2010; Guedes *et al*., 2014), also found that smaller land size was associated with higher probability of being poor. Access to credit reduced the probability of household being poor in certified organic vegetable producing households only, possibly because of high capital requirement and cushioning against possible delays in payments for organic produce supplied to supermarkets and hotels. Berhane and Gardebroek (2011) also found that credit reduced poverty by increasing productivity of household resources.

Finally, social capital variables were also important in determining household poverty status in all four categories. Social capital development is important as it acts as change agent, influencing attitude, perceptions as well as providing the necessary information and knowledge platforms increasing household probability of not being poor. Chantarat and Barrett (2012) showed that social network capital could substitute or complement household productive assets, hence enabling the poor escape the traps of poverty. As Mutersbaugh (2002), Bacon (2005) and Quaedvlieg *et al*. (2014) noted, group membership, or what they call "unionism", provides podium for sharing information and developing common development strategies, pooling resources to benefit from economies of scale. This enhances the ability of group members to participate in different trading systems and reduce vulnerability to poverty. Quaedvlieg *et al*. (2014) add to this with finding that social capital is important in changing the way members perceive themselves and their ability to influence people in their surroundings through their changed actions and enhanced self-confidence. However, Olson (1982) noted that some social groups may not lead to poverty reduction due to their engagement in unproductive activities, stifling members' economic growth.

4.6 Mean treatment effects on poverty

The effect of participation in certified organic production systems on multidimensional poverty is presented in Table 21, which was estimated by equation (15a) and (15b) as detailed by Lokshin and Sajaia (2011). The average treatment effect on the treated (ATT) was -0.073 and -0.181 in vegetable and honey producing households, respectively. This implies that among certified producers, their participation in certified organic production led to about 7 and 18 percentage point less likelihood of being multidimensional poor compared to the counterfactual case (not participating in certified organic production) among vegetable and honey producers, respectively. The findings demonstrate the role of organic certified production on poverty reduction among smallholder producers among participants in certified organic production system.

Table 21: Mean treatment effect from certified organic production

Treatment effect	Vegetable producers		Honey producers	
	Estimate	Std. Err.	Estimate	Std. Err.
Average treatment effect on the treated (ATT)	-0.073	0.087	-0.181	0.109
Average treatment effect on the untreated (ATU)	-0.067	0.053	-0.206	0.118

To policy makers and program planners, their interest is to understand what would be effect of participation in certified organic production on poverty in conventional vegetable and noncertified organic honey producing households if they were to adopt certified organic production. The finding was interesting and is given by average treatment effect on the untreated (ATU). If farmers in conventional vegetable production system were to participate in certified organic production scheme, this would lead to about 7 per cent less likelihood of being multidimensional poor. Hence, they would be better off if they were to participate in certified organic scheme (as opposed to being conventional producers). In the same vein, participation in certified organic production would result to about 20% less likelihood of being multidimensional poor among noncertified organic honey producers if they were to be certified.

However, comparing the results of ATT and ATU, noncertified honey producers would benefit from poverty reduction more than certified producers by about 2 percentage points. In contrast, conventional vegetable producers would benefit the same as organic certified vegetable producer upon certification. Thus, in-cooperation of conventional vegetable and noncertified organic honey producing households in organic certified production would lead to better livelihood outcomes, in form of poverty reduction, but first they must overcome the impediments that limit them from participation in certified organic schemes.

4.7 Determinants of WEIA

In evaluating the effect of certified organic farming on WEIA, the original sample of 237 household was reduced to 203 household in vegetable production system. Conversely, in honey production system the households included in the analysis was 207 from the original 232 households. This was due to unavailability of some women during the survey period in the months of June and July, 2013. Further, there was need to exclude single and widowed women from original sample to evaluate the effect of men characteristics on the level of WEIA. Among the 203 households in vegetable production system, 62 per cent were conventional farmers and 38 per cent were certified organic farmers while for organic honey producers, 49 per cent were noncertified and 51 per cent were certified producers. However, the results did not change much on determinants of participation in certified organic production as presented in Appendix 4. Table 22 and 23 present results on determinants of level of WEIA in vegetable and honey producing households, respectively. The multivariate two limit Tobit estimation was used for the WEIA dimensions and the univariate two limit Tobit used for the overall index. The significant *chi square* in both tables showed that multivariate estimates are more efficient than the univariate estimation. Clinical examination of the result depicts varied effects of socio-economic and cultural factors that influence level of WEIA dimensions and the overall index across the two production systems.

Table 22: Determinants of women empowerment among vegetable producers

Variables	Multivariate two limit Tobit model of the dimensions of women empowerment					Univariate Tobit
	Production	Income	Resource	Leadership	Time	Overall index
Offarm_man	-0.032	0.001	0.033	0.048**	0.046*	0.012
	(0.023)	(0.036)	(0.035)	(0.082)	(0.037)	(0.024)
Offarm_fem	0.488	0.115***	-0.017	-0.007	-0.017	0.003
	(0.031)	(0.035)	(0.034)	(0.078)	(0.035)	(0.023)
Educ_ man	-0.094	-0.018	-0.011	0.067*	0.017*	-0.013**
	(0.016)	(0.018)	(0.018)	(0.041)	(0.018)	(0.012)
Educ_ fem	0.057	0.019	0.033**	0.086	-0.037**	0.019**
	(0.017)	(0.019)	(0.018)	(0.043)	(0.019)	(0.013)
Female age	0.009	0.022***	0.000	0.001	0.003**	0.021***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)
Head _ fem	0.185	0.005	-0.050	-0.121	-0.064	0.058
	(0.041)	(0.047)	(0.045)	(0.105)	(0.048)	(0.031)
Marry age	0.013	0.003	-0.007**	-0.009	-0.002	-0.003
	(0.003)	(0.004)	(0.004)	(0.009)	(0.004)	(0.003)
Age gap	-0.041**	-0.012	-0.002	-0.002**	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)	(0.001)
Group_ het	0. 832	0.070**	-0.064	0.003	0.012*	0.015
	(0.095)	(0.107)	(0.104)	(0.241)	(0.109)	(0.072)
Meet index	0.078	0.085**	0.018**	0.529***	0.100**	0.123***
	(0.046)	(0.051)	(0.050)	(0.116)	(0.052)	(0.035)
Density	-0.184	-0.013	0.026*	0.044	0.006**	0.004
	(0.015)	(0.017)	(0.017)	(0.038)	(0.017)	(0.011)
Trust	0.075**	0.001	0.000	0.068***	0.071**	0.029***
	(0.004)	(0.005)	(0.004)	(0.010)	(0.005)	(0.003)
Agric_ asset	-0.195	-0.006	-0.005	-0.045	-0.034*	-0.022*
	(0.017)	(0.019)	(0.018)	(0.042)	(0.019)	(0.013)
Farm size	0.036	-0.031	0.009	-0.001	0.019**	-0.002*
	(0.011)	(0.012)	(0.012)	(0.028)	(0.013)	(0.008)
ocertprod	0.105	0.054	0.124***	0.314**	-0.017***	0.169**
	(0.071)	(0.079)	(0.077)	(0.179)	(0.081)	(0.053)
Intercept	0.724***	0.169	0.683***	0.307	0.281	0.433
	(0.228)	(0.256)	(0.249)	(0.579)	(0.261)	(0.172)
Correlation						
Production	1.000					
Income	-0.080	1.000				
Resource	0.095	-0.156	1.000			
Leadership	0.006	0.051	0.142	1.000		
Time	-0.075	0.173	0.078	0.189	1.000	

Notes: Numbers in parenthesis are standard errors of the coefficients. H_0: There is no correlation between the error terms LR chi-square (10) = -476.556(p-value =0.000). *, **, ***=significant at 10% 5% and 1% level, respectively.

Table 23: Determinants of women empowerment among organic honey producers

Variables	Multivariate two limit Tobit model of the dimensions of women empowerment					Univariate Tobit
	Production	Income	Resource	Leadership	Time	Overall index
Offarm_man	-0.008	0.034*	0.033**	0.081	0.034	0.018**
	(0.033)	(0.020)	(-0.210)	(0.082)	(0.037)	(0.027)
Offarm_fem	0.061**	0.066**	0.035	-0.041	0.010	0.030*
	(0.031	(0.032)	(0.031)	(0.078)	(0.035)	(0.026)
Educ_ man	-0.033*	-0.029**	-0.029*	-0.002	0.020	-0.018
	(0.017)	(0.018)	(0.017)	(0.043)	(0.020)	(0.014)
Educ_ fem	0.038**	0.045***	0.042***	0.019	0.042**	0.043***
	(0.016)	(0.016)	(0.016)	(0.039)	(0.018)	(0.013)
Female age	0.000	0.000	0.000	-0.001	0.012*	0.000
	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)
Head _ fem	0.150	0.168	0.119	0.036	0.052	0.106
	(0.033)	(0.034)	(0.033)	(0.082)	(0.037)	(0.027)
Marry age	0.008**	0.010***	0.007**	0.003	-0.005	0.016**
	(0.003)	(0.003)	(0.003)	(0.008)	(0.004)	(0.003)
Age gap	-0.002	-0.122**	-0.012	-0.125**	-0.001	-0.021
	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)	(0.002)
Group_ het	0.001	-0.013	0.031	0.015	0.147	0.073
	(0.059)	(0.062)	(0.059)	(0.148)	(0.068)	(0.049)
Meet index	-0.001	-0.018	-0.011	0.055	0.062**	0.015
	(0.049)	(0.051)	(0.049)	(0.122)	(0.056)	(0.040)
Density	0.007	0.009	0.003	-0.040	0.037*	0.003
	(0.019)	(0.020)	(0.019)	(0.047)	(0.021)	(0.016)
Trust	-0.001	0.005	-0.009	0.024	-0.006	0.001
	(0.008)	(0.009)	(0.008)	(0.021)	(0.009)	(0.007)
Agric_ asset	0.011	0.014	0.014	-0.015	-0.004	0.004
	(0.014)	(0.015)	(0.014)	(0.035)	(0.016)	(0.012)
Farm size	-0.028	-0.027*	-0.014	-0.093**	-0.018	-0.029*
	(0.019)	(0.020)	(0.019)	(0.047)	(0.022)	(0.016)
Ocertprod	0.127**	0.016	0.019	0.056***	0.050**	0.051
	(0.049)	(0.051)	(0.049)	(0.122)	(0.056)	(0.041)
Intercept	0.373**	0.318	0.340	0.644	0.367*	0.356**
	(0.199)	(0.207)	(0.200)	(0.498)	(0.227)	(0.165)
Correlation						
Production	1.000					
Income	0.958	1.000				
Resource	0.853	0.878	1.000			
Leadership	0.013	0.050	0.088	1.000		
Time	0.164	0.178	0.161	0.188	1.000	

Notes: Numbers in parenthesis are standard errors of the coefficients. H_0: There is no correlation between the error terms LR chi-square (10) =-432.174 (p-value =0.006). *, **, ***=significant at 10% 5% and 1% level, respectively.

Husband's participation in off-farm activities enhanced the level of women empowerment in leadership and time dimensions in vegetable production systems. In contrast, it significantly influenced positively level of women empowerment in resource and income dimensions other than the overall WEIA index among honey producers. Note that honey producing households are in rural food insecure region and most of their husbands are in the urban areas engaging in off-farm activities. Hence, in the absence of men in the household, women have greater tendency to be involved heavily in agricultural decision making.

Women participation in off-farm activities increased women empowerment in income dimension in both production systems besides production dimension among honey producing households. Off-farm activities provides source of income which women could invest in agriculture and other assets increasing their bargaining power in the household. The income effect in honey production system is interesting in presence of limited opportunities for off-farm activities in rural areas. This raises a policy issue on how to open sustainable off-farm activity opportunities for rural women as a forward gear towards their empowerment. Anderson and Eswaran (2009) found that direct income in the hands of women in Bangladesh positively influenced their decision making power. Further, Agarwal (2001) found that participation in off-farm activities by women in India enhanced their ownership of assets leading to increased bargaining power. Likewise, Jayaweera (1997) argues that woman's own earning increasing her self-confidence and self-reliance.

Increasing the husband level of education significantly increased level of WEIA in leadership and time dimensions, but decreased WEIA in the overall index in vegetable producing households. The implication of this is that highly educated men tend to recognize the need for time and leadership skills of women, but still control household income, resource and production dimensions. This could prove a challenge and requires more attitude and perception change among men in these dimensions. In contrast, increased level of education of husbands reduced the level of women empowerment in production, income and resource dimensions among honey producers. However, comparing the effect of men and women level of education on WEIA, the picture tends to change. The effect of increasing women education level supersedes the negative effects of increasing the men education level in both production systems. Education is imperative in developing knowledge and ability to defend one's stance. Hence, educated women tend to be self-confident and assertive, which enhances their ability and participation in household decision making. Jayaweera (1997) concluded that existing gender ideologies, social and economic constraints concerning educating women in society as an impediment to their empowerment.

Increased age of women led to higher levels of empowerment in income and time dimensions besides the overall index among vegetable producers and in time dimension among honey producers. This could imply that decision making in agriculture progressively increases as women get older probably because of experience and information gained making her accustomed to her role in marriage. This is more so, when women empowerment process is contextualized as stock that has to be accumulated over time. The findings on older women in time dimension depict an impression of them being "contented" with their farming activities perhaps because they are highly immobile and have lesser off-farm activity opportunities compared to younger women.

The age at marriage significantly influenced positively women empowerment in production, income and resource dimension as well as the overall empowerment index in honey producing households only. This could be attributed to the relatively lower age at marriage among rural honey producers compared to peri-urban vegetable producers where there is likelihood of breakage of one's cultural beliefs. Engelen and Kok (2003) argue that higher age at marriage in urban areas is associated with inability of migrants in the new environment to find social connections. Relatively younger age at marriage by women may make them less confident intoning their opinions and may experience difficultly in developing their own identity. Rural areas are associated with early marriages because of lower education levels and cultural conditioned beliefs. This finding provides evidence on the missing link in literature between early marriage and the level of women empowerment in agriculture. Brickell and Chant (2010) argues that younger women in marriage tend to have physical and emotional distress as well as low esteem. This is attributed to the new environment which negatively affects their household decision during initial years in marriage. A delay in year of marriage in Bangladesh by one year, led to a 6.5% higher likelihood of literacy and 0.3 additional schooling years (Ambrus and Field, 2008).

Turning to spousal age gap, increased spousal age gap led to significant decline in women empowerment in production and leadership dimensions in vegetable producing households and income and leadership besides the overall index in honey producing households. Larger spouse age gap makes women more vulnerable and reclusive. Hence, they cannot develop and portray their decision making and leadership skills making men more dominant in decision making in the family unit. Carmichael (2011) found that larger spousal age gap in marriage disempowered the younger spouse in making household and community decisions due to lack of or inadequate self-confidence. Further, the negative effect of larger spousal age gap on women empowerment is exacerbated with early marriages characterized by low levels of education (Guilbert, 2013).

Women social capital dimensions (measured by density of membership, group heterogeneity index, meeting attendance index and level of trust among the group members) had more significant positive effect on the level of women empowerment in vegetable production system than their counterpart. Women in vegetable producing households benefited most from social networks because the groups were highly heterogeneous in their composition resulting from acculturation in peri-urban areas compared to women in rural honey producing households. However, most notable was the positive significant effect of the four dimensions of social capital in vegetable producing households and meeting attendance index and density of membership in honey producing households on leadership dimension of WEIA. This finding demonstrates the transformative role of social capital in leadership development. It accords women and men a platform for exchanging information, experiences and knowledge spirited to development of their leadership and decision making skills in agriculture as well as changing attitude and perception. Fantahun *et al*. (2007) highlights the importance of higher social capital in enhancing women empowerment resulting in reduced under-five mortality in Ethiopia. Further, De Silva and Harpham (2007) emphasizes on the importance of maternal social capital in enhancing child nutrition status in developing countries.

Value of agricultural assets was used in the study as a proxy for wealth. Increased value of agricultural assets and farm size led to a decline in the level of empowerment in time dimension and the overall index of WEIA in vegetable producing households. The finding on the time dimension could be attributed to extra care for the assets, which increases the work load limiting women involvement in leisure activities. However, this could also indicate that in wealthy households, men leading role as breadwinners could be dominant, which limits women involvement in decision making compared to less well-off households where there could be sharing of the breadwinners role between husband and wife. This possibly could be the explanation for insignificant results in honey producing households because of relatively small asset base. Increased farm size led to significant decline in empowerment on income and leadership dimensions and the overall index among honey producers. Bacon (2010) found that women empowerment was negatively influenced by heavy work load in commercialized agriculture and aggravated further with fulltime domestic chores.

To the link between certified organic production and women empowerment, mixed findings were observed in the two production systems. In vegetable producing households, after controlling for potential endogeneity, participation in certified organic production systems had significant positive impact on the production, resource and leadership dimensions besides the overall index of WEIA. However, participating in certified organic farming reduced significantly the level of empowerment in time dimension. This could be due to organic farming being labour intensive requiring more commitment by women, who are the main agricultural household labour suppliers, to production and marketing activities. Kabeer (2001) observed similar finding where microfinance facilities increased women's asset ownership and income, but also increased women's workload in Bangladesh. Anderson and Eswaran (2009) found that women had no control on the income generated from the farms even though they have contributed to its generation in Bangladesh, which disempowered them. Further, Allendorf (2007) and Chhay (2011) argue that income in the hands of women compared to those in men had more positive effects to the welfare of their families, women and the community at large.

In contrast, production, leadership and time dimensions were significantly influenced positively by participation in certified organic production in honey producing households. This could be explained by the trainings women are involved in relating to production activities and their participation in leadership in farmer groups responsible in building their leadership skills. Further, the interactions in groups improved the level of empowerment in the time dimension by giving women time off their routine farming activities as a possible cheapest leisure activity in most rural areas. Though insignificant, participation in organic certified honey production scheme had positive effects in the resource and income dimensions of WEIA.

4.8 Determinants of HDDS level

In evaluating the effect of certified organic farming on HDDS, the original sample of 237 household was also reduced to 203 household in vegetable production system. Conversely, in honey production system the households included in the analysis was 207 from the original 232 households. This was attributed to the need to include women empowerment in agriculture and education of the husband and wife as explanatory variable for HDDS. Hence, some households were dropped due to unavailability of some main women decision makers during the survey to answer questions on women empowerment in agriculture and the exclusion of single/widowed families from the analysis. The descriptive statistics used in the endogenous switching Poisson regression model are presented in Table 24.

Table 24: Descriptive statistics of the variables included in univariate and multivariate two limit Tobit model

Variables	Vegetable producers		Organic honey producers	
	Conventional	Certified	Noncertified	Certified
HDDS	7.19(1.12)	8.99 (1.37)	5.59 (1.13)	7.29(1.06)
Education head	3.45(0.65)	3.58(0.96)	2.22(0.27)	2.54(0.58)
Gender head	0.89(0.31)	0.60(0.49)	0.85(0.39)	0.59(0.45)
Head age	49.98(10.15)	45.92(12.26)	55.89(13.25)	49.71(14.25)
Household size	4.69(1.21)	4.90(1.35)	5.17(1.85)	7.26(1.98)
Off-farm income	0.54(0.22)	0.69(0.32)	0.44(0.40)	0.70(0.35)
Land size	0.91(0.12)	0.82(0.51)	3.45(1.25)	3.37(1.54)
Agricultural assets (‘000)	266.92(247.28)	270.82 (192.45)	152.32(24.89)	188.54(35.21)
System	0.23(0.15)	0.65(0.29)	0.02(0.32)	0.03(0.02)
Number of extension	1.01(0.65)	3.16(1.45)	0.92(0.92)	1.76(1.45)
Number of trainings	6.34(2.13)	7.35(3.29)	10.47(3.41)	12.95(3.64)
Credit access	0.82(0.45)	0.81(0.49)	0.59(0.28)	0.61(0.44)
Market distance	3.47(2.27)	3.41(1.57)	13.02(1.28)	9.65(1.25)
Household social capital				
Density of membership	1.50(1.25)	1.69(1.02)	1.81(1.25)	1.61(1.39)
Group heterogeneity	0.23(0.21)	0.19(0.25)	0.11(0.06)	0.14(0.24)
Meeting attendance	0.83(0.28)	0.94(0.27)	0.57(0.12)	0.71(0.19)
Decision index	0.59(0.45)	0.71(0.41)	0.53(0.17)	0.61(0.31)
Trust	0.58(0.41)	0.61(0.32)	0.63(0.31)	0.69(0.39)
Education husband	2.28(1.05)	3.19(0.98)	2.19(0.93)	2.61(0.91
Education wife	2.50(0.99)	3.06(1.04)	2.11(0.85)	2.39(1.01)
Household size ae	3.82(1.48)	3.89(1.62)	5.03(2.17)	5.27(2.32)
Household Income ‘000	142.59(23.77)	191.93(28.20)	44.25(12.36)	65.42(13.25)
Price of cereals	46.87(2.39)	46.85(2.30)	38.59(2.24)	38.57(2.32)
Price of roots/ tubers	66.92(3.53)	67.10(3.77)	59.47(3.23)	59.44(3.24)
Price of vegetables	27.80(1.97)	27.85(1.93)	28.80(2.80)	28.93(2.87)
Price of fruits	81.13(2.21)	81.54(2.32)	78.02(4.29)	77.46(4.00)
Price of meat	329.70(9.64)	328.72(9.45)	304.34(8.29)	305.11(8.77)
Price of eggs	377.23(21.68)	430.54(22.66)	294.82(4.58)	294.89(5.43)
Price of pulses	91.29(6.77)	93.01(6.56)	79.16(3.73)	79.39(3.93)
Price of milk	65.05(4.01)	65.74(4.52)	41.18(2.29)	41.12(2.19)
Price of edible oil	167.41(5.23)	177.86(5.15)	161.12(2.64)	171.72(2.82)
Price of sugar	118.91(3.71)	118.46(4.05)	115.72(6.00)	115.79(5.83)
Price of beverages	180.89(3.75)	180.79(3.55)	176.49(6.07)	176.04(6.72)
Price fish	344.95(23.94)	345.38(24.41)	-	-
HDDS	6.52(1.37)	8.03(1.75)	6.65(1.50)	7.29(1.30)
Women empowerment	0.36(0.16)	0.41(0.28)	0.35(0.23)	0.38(0.32)

Note: Figures in parenthesis are standard errors of the respective means.

The first stage of the endogenous switching Poisson regression model is presented in Appendix 4 to avoid redundancy. The second stage of the model involved the assessment of determinants of HDDS, whose results are presented in Table 25. According to Coulson *et al.* (1995) and Terza (1998), θ estimate is a test for endogeneity and self-selection bias. The $\theta's$ significance in both production systems except among organic honey producers demonstrates the presence of selection bias and endogeneity, hence justifying the use of the two staged model. The positive and significant $\theta's$ among certified producers imply that unobservables determining HDDS and unobservables that determine participation in certified organic schemes are correlated. This was evidence of adverse selection in both production systems. Thus, certified producers had certain hidden characteristics. The differences in estimated coefficients of noncertified and certified producers present a confirmation of heterogeneity that exists between groups and across production systems. The variables included were from prior related studies (Yodanis and Lauer, 2007; Thorne-Lyman, 2010; Rashid *et al*., 2011; Bhagowalia *et al*., 2012; Uraguchi, 2012, Ramirez, 2013).

Table 25: Parameter estimates for the determinants of HDDS

Variables	Vegetable producers				Organic honey producers			
	Conventional		Certified		Noncertified		Certified	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Head age	0.010	0.012	0.025 **	0.017	-0.011	0.017	-0.024	0.017
Education husband	0.043	0.186	0.267	0.257	0.338	0.283	0.030	0.168
Education wife	0.247***	0.196	0.352**	0.214	0.049**	0.253	0.315*	0.164
Women empowerment	0.560	0.250	0.264***	0.048	0.193**	0.470	0.333***	0.790
Household size ae	-0.020*	0.109	0.229	0.122	-0.128**	0.011	-0.138***	0.077
Land size	0.332	0.239	0.221***	0.160	0.066	0.077	-0.069	0.059
Market access	0.060	0.489	-0.280	0.590	-0.285**	0.724	-0.030***	0.337
Density of member	0.117	0.154	-0.077	0.208	0.201***	0.147	0.082***	0.132
Meeting attendance	0.409	0.698	-0.387	0.537	0.019**	0.590	0.087***	0.483
Group heterogeneity	0.121**	1.145	0.371***	0.035	0.018	0.196	0.120***	0.103
Household income	0.055 *	0.082	0.207***	0.112	0.057	0.248	0.526**	0.145
Price of cereals	-0.141**	0.070	-0.049***	0.076	0.039	0.090	0.044	0.090
Price of roots /tubers	0.029**	0.048	-0.013	0.048	-0.147**	0.164	-0.044**	0.043
Price of vegetables	0.120	0.099	-0.214	0.123	0.047	0.056	-0.047	0.061
Price of fruits	-0.018*	0.085	-0.077	0.072	-0.026***	0.046	-0.054*	0.034
Price of meat	0.004	0.017	-0.004**	0.018	0.025	0.024	-0.001**	0.022
Price of eggs	0.004	0.009	0.010	0.018	0.040	0.047	-0.041	0.031
Price of pulses	-0.007	0.025	-0.055*	0.027	0.017	0.054	-0.012	0.040
Price of milk	-0.040***	0.037	0.033	0.045	-0.052*	0.107	0.129*	0.071
Price of edible oil	0.024	0.036	0.064	0.038	-0.110**	0.066	0.045***	0.047
Price of sugar	0.057	0.039	-0.044	0.043	0.045	0.035	-0.033*	0.023
Price of beverages	0.068	0.046	0.005	0.059	-0.014	0.038	-0.041	0.022
Price of fish	-0.011**	0.007	-0.002*	0.008	-	-	-	-
Constant	-17.916	14.584	-19.120*	20.296	-21.549*	17.831	-9.092	15.186
θ	0.351*	0.106	0.145***	0.282	-0.705	0.053	0.561***	0.151

Notes: *, **, ***=significant at 10% 5% and 1% level, respectively.

Older household heads had higher HDDS in certified organic producing households only. Older household heads have more knowledge by experience and thus would tend to diversify their diet because of exposure to benefits of better household nutrition. Further, older household heads have accumulated enough resources, which enhances their purchasing power. Higher maternal education was associated with higher HDDS in all the four categories. Education of wife in the household is important as education exposes them to knowledge, which creates awareness on the role of better household nutritional status, thus the tendency to increase household dietary diversity. Further, higher maternal education enhances understanding of nutritional information, which improves the ability to model and apply the information, which is vital in increasing household dietary quality. Similar findings was reported by Nguyen *et al.* (2013), where women with low education status had tendency to have poor dietary quality in Vietnam. Prior studies (Wardle *et al*., 2000; De Vriendt *et al*., 2009) also found positive association between nutritional knowledge and women education level, which posits the need by policy makers on how to enhance women education for better household dietary outcomes.

Women empowerment in agriculture was measured by the level decision making of the chief household female decision maker relative to that of the husband in the household. The results show that increasing the level of decision making by women at the household level increases HDDS in all categories except conventional vegetable producing households. A critical look at the results reveals that the effect was bigger and more significant at 1% level among certified producing households. The general implication of this finding is that increased women decision making in households translate to higher HDDS and it is more effective in presence of nutritional knowledge. FAO (2006) argued that income and resources under control women have greater chances of improving household food consumption, child malnutrition reduction thus increasing family wellbeing. The result is similar with Lépine and Strobl (2013), where women bargaining power over household decisions improved child nutritional status in Senegal. Further, similar link was found by Richards *et al*. (2013), where increased women involvement in decision making increased child health and nutrition in low and middle income countries.

Household size in adult equivalents captured the family members age-sex structure was also an important variable in explaining dietary quality. An increase in household size significantly decreased HDDS in conventional vegetable producing households as well as in both noncertified and certified organic honey producing households. However, the effect was much stronger in rural honey producers possibly because of larger household size. This could be attributed to larger families having higher food consumption, which translates into higher food expenditure. Thus, such households would first consider having some food in their stomach before thinking of quality of food they take. Similar inverse relationship was reported by Uraguchi (2012) on the food security status of rural households in Ethiopia. Contrary to the findings, Rashid *et al*. (2011) reported that households with higher number of members was associated with higher HDDS because of consumption expenditure economies of scale and such households would allocate more time to kitchen gardening, which increases HDDS.

Larger farm size increased significantly HDDS among peri-urban organic certified producers. This result is plausible as in peri-urban areas the problem of land scarcity is severe than in rural areas and having learnt the importance and practices of bio-intensive crop-livestock system diversification, increased land size would be associated with higher household dietary quality. However, honey producing households do not benefit from their relatively large land size in rural areas because of poor climatic conditions as it is a semi-arid area and the farmers do very minimal irrigation on their farms. Market access measured in terms of distance to the nearest market was found to significantly lower HDDS in honey production system only. Honey producers are located in semi-arid region and they depend heavily on markets for supply of food products, where their situation is further worsened by the deplorable road conditions hindering movement to the sparsely available markets. Hence, households who are located far from the market are likely to record lower dietary diversity because of limited mobility. FAO (2013) notes that enhanced access to markets and improved infrastructure among smallholder vegetable, livestock and fruit producers has the potential of increasing food diversity in both rural and urban markets

Turning to household social capital, higher social capital measured by group heterogeneity index, density of membership and meeting attendance index were found to be vital in increasing the HDDS in all the four categories. However, group heterogeneity was important in explaining the higher HDDS in peri-urban areas because of diverse population with different cultural traits, which tends to increase diversity in knowledge sources. In rural areas, the population is relatively homogenous and the results indicate that higher meeting attendance index and higher number of group membership are important in exposing the household's members to knowledge, which influences their nutritional outcome. Social capital is important in shaping social interaction of members in the society, providing podiums for accessing new knowledge and sharing of ideas on nutritional aspects, which proves essential in altering food consumption behaviours of members. Motohashi *et al*.,

(2013) found significant association between social capital and high interest in dietary pattern.

Economic access of food at the household level was measured by the effect of household income on HDDS. All groups except the noncertified organic honey producing households reported an increase in HDDS with increased household income. However, most notable was the stronger and larger effects of increased income for the certified farmers in vegetable and honey producing households. This result reflects the potential role of better dietary quality among smallholder farmers in presence of nutritional information and higher income at the household level. Similar finding was reported by Bhagowalia *et al*. (2012), who concluded that higher household income in India had modest effect on household nutrition in case of deficient nutritional information. Further, Thorne-Lyman *et al.* (2010) found that, there was a significant association between dietary diversity score and per capita food and total expenditure by households in rural Bangladesh after controlling socioeconomic factors.

HDDS was also sensitive to market food prices faced by households across the four groups in all food groups except vegetables, eggs and beverages. The coefficients estimated are positive and negative indicating the substitution and complementarity effect within and between food groups, hence increasing or reducing HDDS. However, notable was sensitivity of price of cereals which is the main staple food in developing countries in vegetable producing households. This implies that in urban areas, increased maize prices leads to farming households substituting their consumption with available cheaper food groups in markets unlike households in rural areas who have limited varieties of food groups in their markets. However, Rashid *et al.* (2011) reported positive effect of prices on all food groups except edible oils and argued that price effect on dietary diversity is as a result of positive household income compensation.

4.9 HDDS treatment and heterogeneity effects

Results in Table 26 present the expected dietary scores under the actual and counterfactual situations. The observed HDDS are given in cells (a) and (b) as about 9 and 7 for organic certified and conventional producers respectively and about 7 and 6 for certified and the non-certified organic producers respectively. Comparing the figures of cells (a) and (b) in any of the production systems would be misleading because of differences that exists between the two groups. Cells (a) and (c) provides comparison of certified producers and their counterfactuals. The results implied that if certified producers were not certified, they would have reported 1.21 (about 16%) and 1.08 (about 17%) less HDDS among vegetable and honey producers respectively. Conversely, the households who were not certified would have reported 1.76 (about 24%) and 1.71 (about 31%) more HDDS among vegetable and honey producers respectively if they participated in certified organic production. The implication of the results is that participation in certified organic production systems significantly increased HDDS in both production systems. However, it should be highlighted that the effect of participation in certified organic production systems was significantly smaller for household that in reality participated in organic certified production than their counterparts who did not participate. This was demonstrated by the negative significant transitional heterogeneity (TH) in both production systems.

Table 26: Average household dietary diversity score treatment and heterogeneity effects

	Decision stage		
Sub-populations	Certified	Non-Certified	**Treatment effect**
Vegetable producers			
Organic certified households	(a) 9.00(1.37)	(c) 7.78(1.09)	TT= 1.22(0.48)***
Conventional households	(d) 8.95(1.15)	(b) 7.21(1.12)	TU= 1.76(0.90)***
Heterogeneity effects	BH_1=0.05 (0.16)	BH_2=0.57(0.20)*	TH= -0.55(0.81)*
Organic honey producers			
Households that are certified	(a) 7.32(1.06)	(c) 6.21(1.90)	TT= 1.11(0.71)***
Households that are not certified	(d) 7.30(1.09)	(b) 5.59(1.13)	TU= 1.71(0.86)***
Heterogeneity effects	BH_1=-0.02(0.06)	BH_2=0.62(0.18)**	TH= -0.63(0.54)**

Notes: The standard errors are in parentheses. *, **, ***=significant at 10% 5% and 1% level, respectively. See also the notes given in Table 6.

Further, in the heterogeneity effects row in Table 26, the actual nonparticipating households, upon participation in certified organic production would have had the same HDDS in the counterfactual situation (BH_1) in vegetable and honey producing households. Likewise, the results indicated that vegetable and honey producing households who truly participated in certified organic production would have had significant more HDDS than household who again in reality did not participate (BH_2). The implication of the results is that, certified organic participating and nonparticipating households in vegetable and honey production systems exhibit some form of heterogeneity which makes participating households better in HDDS regardless of the treatment in form of certified organic production systems.

CHAPTER FIVE: CONCLUSION AND POLICY IMPLICATIONS

5.1 Conclusion

In both vegetable and honey production system, younger farmers with higher level of education and higher social capital in terms of group heterogeneity and decision making index in groups were more likely to participate in certified organic production. Participation in off-farm activities, having higher asset base, more trainings and having closed system of keeping livestock were also found to enhance the likelihood of participating in certified organic vegetable production systems. In contrast, larger household size and shorter distance to the nearest market significantly increased the likelihood of being certified organic honey producer.

Findings on stratification multilevel and matching-smoothing methods of estimation heterogeneous treatment effects revealed presence of heterogeneity of organic certification effects on household income. Farmers with higher propensity to be certified benefited most from organic certified vegetables production. These groups of farmers are advantaged socially and economically. When farmers self-select themselves in certified organic vegetable production program means that farmers in upper stratums “sorted out gains” from participating in certified organic vegetable production. In honey production systems, farmers across all propensity scores strata benefit significantly. Nonetheless, those in the middle strata benefit most. Thus, organic certification has not only led to significant increase in household income, but also an important policy issue of having a socially equitable society being advanced by the scheme, unlike in vegetable production system.

On multidimensional poverty, rural poor were relatively poor (53 per cent of organic honey producers and 47 per cent certified organic) compared to peri-urban producer (45 per cent for conventional and 42 per cent for organic certified producers). On determinants of multidimensional poverty status, participating in off-farm income activities increased the probability of not being poor in both production systems. This raises a policy concern on the importance of diversifying farm income through creation of sustainable off-farm activities. Of concern also is the high dependency ratio in rural areas, which significantly increase the probability of being poor. This calls for the need to reevaluate the effectiveness of existing family planning policies in rural areas.

Certified organic production reduced the probability of being poor in the two production systems. Certified organic producers were 7 and 18 percentage point less likely to be poor compared to their counterfactual case (not participating in certified organic production) among vegetable and honey producers. Of interest to policy makers and program planners was the average treatment effect on the untreated results in understanding the possible effect on poverty if noncertified producers were to be certified. From the findings, noncertified producers would benefit from certified organic production; at it reduces the probability of being multidimensional poor by about 7 and 20 per cent points among vegetable and honey producers, respectively. Therefore, noncertified farmers would be better off being certified in both production systems. This could be achieved by enhancing their socioeconomic and institutional drivers of participation in the fast emerging and growing certified organic market for smallholder farmer livelihood improvement through poverty reduction.

The study has provided micro level evidence on the level of WEIA and the impact of certified organic agriculture and other social, economic and cultural factors on the level of women empowerment. This was achieved by adapting the multidimensional methodology proposed Alkire *et al*. (2013) of measuring WEIA using data from peri-urban vegetable and rural honey producers in Kenya. Evaluating the effect of participation in certified organic production systems on WEIA was deemed important in the face of rising number of certified organic schemes meant to commercialize smallholder agriculture and tackle gender related and cultural constraints that thwart women empowerment in developing countries.

The study empirically determined the "low" level of women empowerment question in empirical literature. On average, women involvement in agricultural decision making was about 38% and 35% in vegetable and honey producing households, respectively. More social, cultural and economic constraints seemed to limit higher levels of WEIA more in rural honey producing households compared to peri-urban vegetable producing household. Findings from univariate and multivariate two limit Tobit models affirmed Farnworth and Hutchings (2009) hypothesis that organic certified production systems open knowledge spaces for women contributing to their empowerment, but in some dimensions of WEIA. The study accentuates the importance of knowledge space in certified organic production systems in enhancing women involvement in agricultural decision making.

The effect of wealth measured in terms of value of agricultural assets to WEIA was surprising in the vegetable producing households. Increased wealth was associated with decreasing empowerment levels attributed to men commanding ownership of the wealth making them dominant in household decision making. Hence, though assets were not influencing WEIA in rural areas, a lesson has to be learnt from such findings. Even if women are involved in production and whole income from their production goes to direct consumption, it does not improve their household bargaining power unless part of the income is invested in assets owned jointly or solely by women. The importance of efforts geared towards enhancing the different dimensions of social capital was also demonstrated in enhancing level of WEIA, particularly in the leadership dimension. Higher social capital accords men and women better platform to share ideas, knowledge and demonstrate their decision making capabilities important for changing perception and attitude leading to women empowerment.

The study has also provided empirical evidence on the effect of participation in certified organic production systems on household dietary quality in peri-urban and rural areas. This was on the premise that integrated nutritional knowledge in extension systems among certified organic producers institute avenues for positive behavioural change in household food consumption. The study fails to reject the hypothesis that organic production systems provide knowledge base to farmers leading to better nutritional outcomes. Hidrobo *et al*. (2014) also had similar findings in Ghana, where nutritional knowledge played role in diet behavioural change in a randomized experiment involving cash, food or vouchers.

5.2 Policy recommendation

For policy analysts and program planners, the findings on heterogeneous treatment effect model depicts that implicit assumptions on homogeneity of effects of such pro-poor organic certification interventions might be misleading. There is need to systematically evaluate the heterogeneity in effect of pro-poor programs in order to customize and redesign such livelihood improvement programs to achieve effectively their desired objectives. Exclusion of poor farmers from such emerging pro-poor high value chain might lead to further marginalization as socially and economically advantaged farmers self-select in such programs due to initial screening shortfalls during enrolment. Enhancing pro-poor participation in such emerging high value supply chains requires proper targeting and screening of famers during enrolment as well as enhancing other drivers that increase the likelihood of participation like training programs and building higher social capital.

Further, higher physical (in terms of agricultural assets) and social capital were found to reduce the probability of being poor. These findings underpin the importance of encouraging reinvestment in agricultural productive assets and need for strengthening societal ties. Stronger societal social capital could provide avenues for attitude and perception change while engineering information and knowledge transfer important for human development.

There is need to strengthen and form new local institutions as agents of change and development.

Turning to the effect of certified organic production on WEIA, the importance of women empowerment geared information through efficient extension service delivery mechanism is critical in changing men and women behaviour leading to increased level of WEIA. However, such knowledge areas should be customized to target specific dimensions of WEIA, so that collectively there would be greater impact. Further, such social norms changing initiatives should also include both men and women to demystify negative subjective opinion of WEIA as a “women affair”, but as a step towards better household and community livelihood. Further, the findings on the effect of higher levels of education in women on WEIA demonstrate the need for more efforts on girl-child education in fighting women disempowerment while not neglecting the boy child education to overcome possible rebellion among men. Interventions geared towards enhancing girl-child helps to reduce low age at marriage and the higher spousal gap particularly prone in rural areas. Girl-child education increases their bargaining powers in marriage, as education allow further mental development making them self-confident and assertive. Women participation in off-farm income activities could prove essential in enhancing WEIA in rural areas. The implication to policy would be on how to open rural areas to create more sustainable off-farm activities opportunities for women to induce their empowerment further.

The level of WEIA was also influenced by several socioeconomic and cultural factors differently in vegetable and honey production systems. Women participation in off-farm income activities could prove essential in enhancing WEIA particularly in rural areas. The implication to public policy would be on how to open rural areas to create more sustainable off-farm activities opportunities for women to induce their empowerment further.

Finally, the findings on the effect of household participation in certified organic production demonstrates the importance of passing nutritional knowledge to farmers which are geared towards behavioural change thus better dietary quality. Therefore, promotion of integrated economic, environmental and nutritional behavioural change farmer extension programmes such as certified organic production systems schemes proves imperative among smallholder farmers in making informed food choices resulting to better household nutritional outcomes. However, such intervention programs should also consider the socio-economic and institutional characteristics as well as differences in livelihood strategies that exist between urban and rural smallholder farmers. Further, such efforts should be complimented by policies that reduce economic (high cost of food) and physical blockades in access of quality and healthy foods by smallholder farmers, particularly in rural areas where HDDS is relatively low. It is also important for policy makers not only focus on staple food adequacy, but also to integrate nutritional diet quality components in their programs for better dietary outcomes.

5.3 Further research

The main aim of the study was to evaluate the on-farm effect of certified organic production on the livelihood of smallholder farmers in order to recommend relevant policies geared towards enhancing the effectiveness of certified organic production schemes in achieving improved livelihood outcomes in Kenya. However, the study proposes future research;

1. in similar context using panel data to investigate potential dynamism in effect so as to affirm or refute the hypothesis that certified organic production is pro-poor, enhances women empowerment in agriculture and household dietary quality over time;
2. on the sustainability of the organization and social ties as a result of farmers dependency on support from donor and nongovernmental organizations in case they withdraw from the program in both production systems requires further interrogation;
3. to evaluate the effect of WEIA on agricultural productivity and its role in household conflicts and;
4. to determine how diversity within and between food groups is influenced by socioeconomic and institutional characteristics. The implication of food supply and distribution systems and how they affect nutritional outcomes in rural and urban areas warrants further research.

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APPENDIX 1: HOUSEHOLD SURVEY QUESTIONNAIRE

Topic: Effect of Certified Organic Production Systems on the Livelihood of Smallholder Farmers in Kenya

INTRODUCTION

HALLO, my name is ____________________and I am part of a team from Egerton University, who are studying aspects to do with agricultural development with emphasis on organic production in the Kenya. Your participation in answering these questions is highly appreciated. Your responses will be **COMPLETELY CONFIDENTIAL** and used solely for research purposes together with other 469 households. If you indicate your voluntary consent by participating in this interview, may we begin? If you have any questions or comments about this survey, you may contact the Project coordinator through the following address: **Mr. Oscar Ingasia Dept. of Agricultural Economics and Agribusiness Management, Egerton University, P.O. Box 536, Egerton. Cell phone: 0721794827.** Email address: ingasiaoa@yahoo.com.

SECTION A: GENERAL INFORMATION

1. Date of interview **date**_________________
2. Name of enumerator _________________________ **enum**________________
3. Name of Respondent (optional) **Respname**_____________ **memid**_______________
4. Respondent's gender. 1=Male 0= Female **gender**_______________
5. Phone number **phone**________________
6. **Structure of land ownership**

Ask the following with regard to the total land (in acres) under the control of the household

Land.sav

Total agricultural land	Organic crops	Inorganic enterprises
totland	***orgland***	***inorglnd***

APPENDIX 2: WOMEN EMPOWERMENT SURVEY QUESTIONNAIRE

Topic: Effect of Certified Organic Production Systems on the Livelihood of Smallholder Farmers in Kenya

INSTRUCTIONS TO ENUMERATORS

This instrument is meant to evaluate the effect of certified organic farming on women in each of the sampled households. Apart from administering the main questionnaire to the household you are kindly required to take some few minutes with the main female decision maker in that particular household to fill this questionnaire. Note that all questions are concerned with the characteristics of main female decision maker.

INTRODUCTION

HALLO, my name is ___________________and I am part of a team from Egerton University, who are studying aspects to do with agricultural development with emphasis on organic production in the Kenya. Your participation in answering these questions is very much appreciated. Your responses will be **COMPLETELY CONFIDENTIAL** and will be used solely for research purposes together with other 469 households. If you indicate your voluntary consent by participating in this interview, may we begin? If you have any questions or comments about this survey, you may contact the Project Coordinator through the following address: **Mr. Oscar Ingasia Dept. of Agricultural economics and Agribusiness Management, Egerton University, P.O. Box 536, Egerton. Cell phone: 0721794827.** Email address: ingasiaoa@yahoo.com

APPENDIX 3: ITEMS USED IN MEASURING WOMEN EMPOWERMENT IN LEADERSHIP DIMENSION

Instructions to the enumerator: This section aims at understanding the leadership potential of the woman. Probe to get honest answers on the questions as no answer is correct or wrong. Use the following scale of; 1 = Strongly disagree 2= Disagree 3= Neutral 4=Agree 5=Strongly agree to indicate the scale that accurately describes the woman from the answers she gives. Illustrate some questions with the appropriate community groups and assets that are available to gauge if;

No	**Question**	Rank
1.	She can list her three greatest weaknesses as a person[a]	
2.	Her actions in the family and the community reflects here core values [b]	
3.	She seeks other peoples opinion before making up her mind [c]	
4.	She openly shares her feelings with others in the family and community [d]	
5.	She can list her greatest three strengths [a]	
6.	She does not allow group pressure to control her actions [b]	
7.	She rarely “lie” in front her friends , family and community members [d]	
8.	She accepts her feelings about herself [a]	
9.	In controversial family and community issues , people normally know my stand [b]	
10.	She is guided by her morals in undertaking community and family duties as leader [b]	
11.	She listens to others in the community and family ideas before making up her mind [c]	
12.	Once she makes mistakes in the family and community, she admits [d]	
13.	She listens critically on the ideas of those who disagree with her ideas in the family and community [c]	
14.	She seeks feedback on what truly she is as a person in the family or community [d]	
15.	She does not emphasize her point at the expense of others in the family and community [c]	
16.	She does seek feedback to understand her leadership [a]	

a, b, c, d relates to item questions regarding self-awareness, internalized moral perspective, balanced processing and relational transparency, respectively. The figures of the rank are summed and transformed to 100%.

APPENDIX 4: FACTORS INFLUENCING FARMERS' PARTICIPATION IN CERTIFIED ORGANIC PRODUCTION

Variable	**Vegetable producers**		**Honey Producers**	
	Coeff.	Std. Err.	Coeff.	Std. Err.
Head age	-0.026*	0.011	-0.044**	0.015
Gender head	-1.846	0.419	0.849	0.345
Education head	0.323**	0.140	0.409**	0.186
Household size	0.173	0.104	0.350***	0.079
Off-farm employment	0.708*	0.329	0.094	0.042
Log of agricultural assets	0.898*	0.150	0.170	0.149
Farm size	0.208	0.439	0.047	0.204
Information sources				
Farmer-to-farmer extension	0.022**	0.450	0.092***	0.456
Government extension	- 0.016	0.231	0.009*	0.112
Non-governmental extension	0.044***	0.201	0.521***	0.125
Print and visual media	0.040	0.013	-0.032	0.082
Number of trainings	0.617**	0.325	-0.215	0.363
Market distance	-0.149	0.055	0.050***	0.056
Credit access	0.519	0.378	0.573	0.506
Social capital variables				
Density of membership	0.043**	0.166	-0.117	0.063
Meeting attendance	0.165	0.375	1.216**	0.495
Group heterogeneity	0.144***	0.092	0.840**	0.179
Decision index	0.189**	0.069	0.273*	0.076
Trust	-0.067	0.066	0.236	0.284
System of livestock keeping	0.859**	0.309	-	
Constant	-8.900***	1.906	-6.099 **	2.177

Note: *, **, ***=significant at 10% 5% and 1% level, respectively.