

**THE CONTRIBUTION OF HUMAN CAPITAL DEVELOPMENT ON
AGRICULTURAL LAND-USE INTENSIFICATION: ANALYSIS USING MWEA
IRRIGATION SCHEME DATA**

BY

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DECLARATION

This Research Paper is my original work and has not been presented to any institution for the award of Diploma or Degree.

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DEDICATION

This study is dedicated to my parents, siblings and friends.

ACKNOWLEDGEMENT

To complete this work, the unconditional support of my friends and family, and the diligent endeavor of my supervisor Dr. Sule are invaluable. God has favoured and rewarded my/our efforts.

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ABBREVIATIONS AND ACRONYMS

ADF - Augmented Dickey-Fuller Test

ASTI - Agricultural Science and Technology Indicators

ECM - Error Collection Model

FAO – Food & Agriculture Organization

FAOSTAT – Food & Agriculture Organization of the United Nations Statistics Division

GDP – Gross Domestic Product

GINI – Greater Income Inequality

GOK – Government of Kenya

HCD - Human Capital Development

HDI – Human Development Index

IFAD – International Funds for Agricultural Development

IFPRI – International Food Policy Research Institute

KARI – Kenya Agricultural Research Institute

KASDC - Kenya Agricultural Sector Data Compendium

MDG – Millennium Development Goals

OLS – Ordinary Least Square

PP – P-Perron Test

SSA – Sub-Saharan Africa

TFP - Total Factor Productivity

UN - United Nations

UNDP - United Nations Development Programs

WHO - World Health Organisation

Key words: Human Capital Development, Agricultural Land-use Intensification, Agricultural Productivity, Total Factor Productivity, Human Development Index

ABSTRACT

The agricultural sector contributes greatly to the economic growth of Kenya. The sector employs more than half of national workforce and above 80% of citizens depends on agriculture as a source of livelihood. The challenge of land expansion to achieve high agricultural productivity and food security has resulted to agricultural land-use intensification as the major solution. In order to achieve intensification of agricultural land-use, human capital development is imperative. To motivate public and private investment in HCD, there is need to evaluation the contribution of HCD on the agricultural land-use intensification. This study employs a modified Cobb-Douglas production function to estimate the contribution of HCD on the TFP of the agricultural sector. Agricultural land-use intensification is a TFP measure, which estimates the share of non conventional inputs on the agricultural output.

The explanatory variable explained 55.4% of the depend variable of the study. Only 44.6% of agricultural TFPg was not explained by the regressed model. The included HCD indicators were significant to the model, demonstrated by their respective F-statistics which were less than the critical value of 0.05 in 5% level of significance. Education with a coefficient of 3.882754 considerably contributed to the agricultural land-use intensification compared to other HCD indicator variables of ill-health and income. Land is also critical in the growth of TFP. According to the findings of this study, investment in education, health and better market conditions is necessary to achieve desired level of agricultural land-use intensification.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Agriculture is the most practiced economic activity by most households in SSA. According to World Bank (2013) report, agricultural sector is a source of employment for over 55 % of workforce in most SSA countries. In addition, agriculture is a source of livelihood for over 80% of the African population, according to FAO (2013). A 2012 study by IFPRI (2013) stated that agriculture would remain the dominant potential-source of employment for the rising rural population in SSA. This rural population is estimated to have increased by nearly 30% by 2050, majority of whom will be youth. According to IFAD 2012 Farmers Forum, there is need to invest in human capital development among the rural population and measure its impact on agricultural productivity. UN Annual Ministerial Review of 2012 recognized the significant role of developing rural human capital in reducing food insecurity and poverty (FAO, 2013). IFPRI study found that agricultural sector incremental growth could be achieved by improving the productivity of units of land and labor.

The overall economic growth in Kenya has been greatly attributed to the growth in the agricultural sector. This is due to the critical role it plays in overall GDP, employment, foreign exchange earnings and other backward and forward linkages (World Bank, 2008). The sector has faced major challenges including need to upscale farm yield in order to meet growing demand for food, without degrading natural resources. Kenyan farmers, like in many SSA countries have adopted two major ways of increasing farm productivity. Expansion of the land area under agricultural production, also known as

extensification has been employed as a major ways of preventing food crisis and satisfying the future demand of agricultural product. However, intensification of agricultural land-use is being considered as a contemporary approach of overcoming the challenges associated with extensification and other traditional approaches.

The capacity of application of traditional method of farming to sustain the demand for food has been challenged by rapid population growth (Lambin, Rounsevell & Geist, 2000). According to Nkamleu (2011), studies since 1970s shows that farmers achieved expansion of agricultural land through clearing of bushes and forest. However, recent studies indicate that marginal lands and water catchment areas have offered alternative ways of extensification. This has raised critical question of environmental degradation and sustainable agricultural development. Growing scarcity of land in Kenya has fostered a hurdle towards land expansion. This has shifted focus to agricultural land-use intensification to achieve self-sufficiency in food production, considering the population pressure.

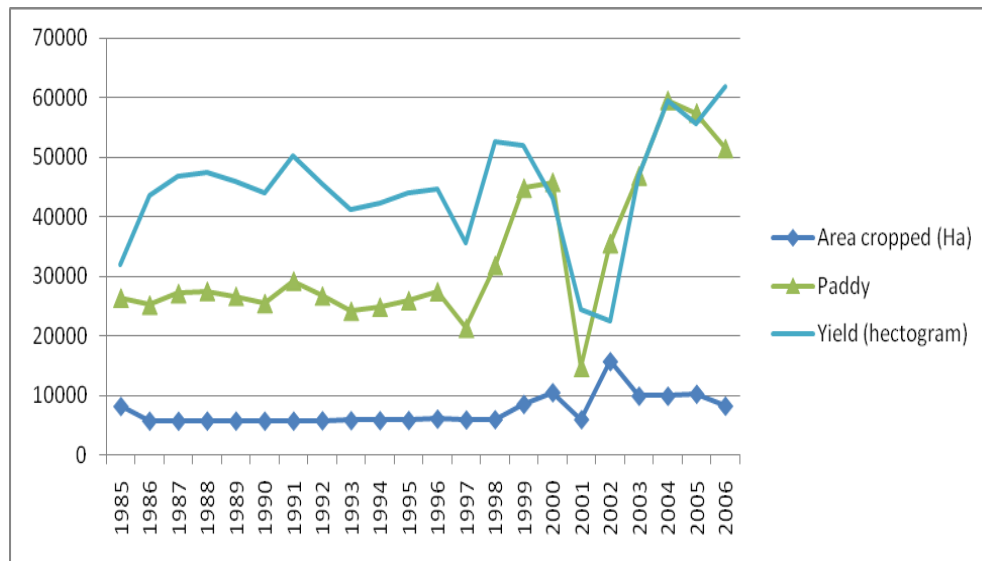
Extensification of Agricultural land has been limited due to scarcity of land resource and infinite demand for land (Tiware, 2009; Doos, 2002). Extensification comprise the expansion of land-use, especially for livestock or crop farming. Factors such as urban expansion, environmental sustainability, road and game reserves and infrastructural development are increasingly affecting expansion of agricultural land. Expansion of agricultural land remains a critical observable fact in the analysis and projection of scarcity and management of natural resource-endowment (Hertel, 2010). On the other hand, intensification of land-use, which is the focus of this study, entails the analysis of observed yield gaps between different production frontier-regions and agricultural TFP.

There is growing global concern over how to increase agricultural productivity without degrading the environment and increasing human-animal conflict, arising from clearing of forests and bushes to expand agricultural land (Deininger, 2011; Shafiq & Rehman, 2000). This has given attention to land-use intensification. Given the limited and fixed land-resource, focus has shifted from expansion of agricultural land to land-use intensification as the alternative approach to increasing agricultural productivity and thus economic growth (Pretty, Toulmin & Williams, 2011; Ewert, 2005).

1.2 Overview of Mwea Irrigation Scheme

Since its establishment in 1956 as a rice growing scheme, Mwea irrigation scheme has grown to be the largest single irrigation scheme in Kenya. The Scheme has 30,350 acres with only 16,000 acres established for paddy production and 4,000 acres considered as jua kali out-growers paddy production regions. The rest of the schemes acreage is under other crops including subsistence and horticultural, while other are used for public utilities and settlement. Most development of land for paddy cultivation is undertaken by individual farmers. Infrastructure in the scheme has been poorly developed with the existing requiring rehabilitation. However, the scheme has recently attracted funding from World Bank and government of Japan.

Figure 1.1: Rice Production in Mwea Irrigation Scheme from 1985 to 2006



Source: Based on data from KNBS, 2007

Growth of productivity of Mwea irrigation scheme has been constantly fluctuating over the years. In the recent years, increasing investment in water for irrigation and more land put under paddy production have enhanced productivity of the scheme. The government of Kenya has given considerable priority to such irrigation scheme as Mwea. The scheme has been facing challenges that are common to many farming activities in Africa, which have limited the capacity of the scheme to increase its productivity per unit land.

1.3 The Interdependence between HCD and Economic Growth

Growth of the Kenya's agricultural sector greatly influences the overall economic growth. According to Srinivasan (1994), achieving economic growth and development requires an economy to have capital and knowledgeable human resources, to control various sectors of the economy. However, Srinivasan claimed that achieving the necessary HCD, a certain level of economic growth is imperative. Thus, HCD is both a

means and product of economic growth. Malecki (1997) examined the effect of development of technology, which is a revolutionary and innovative application of knowledge and capital on economic growth and development. The syntheses of technological changes with knowledge and professional experience have led to improvement in productivity of different sectors. Consequently, according to Srinivasan (1994), technological advancement and knowledge is incidence to economic growth. This explains the emergence of modern technologies according to Malecki (1997), from developed countries and slow synthesis of new technologies in developing countries.

The interdependence between HCD and economic growth led to establishment of human development index (HDI) in 1990, to measure the extent in which economic growth contributed to human development. Improved human welfare was seen as the real wealth of nations, which would result to HCD. Emphasize was laid on human capital as an imperative factor in the growth agenda of the developing economies. The HDI underscores that people and their capabilities are the ultimate criteria for evaluating a country's development and not economic growth alone. Thus, the HDI of a country is an annual measure of people's welfare and their capabilities (human capital). The HDI is a summary measure of average achievement in key human development dimensions. These are decent standard of living, being knowledgeable and long and health life (UNDP, 2015b). The HDI computation according to UNDP formula (appendix 1) is explained in the next paragraph.

1.3.1 Education, Health and Income HDI Dimensions

Life expectancy at birth assesses the health dimension. Life expectancy index is calculated using 20 and 85 years as minimum and maximum values respectively. Education index is calculated by combining two indices using arithmetic mean. These indices are Mean Years of Schooling (MYSI) for adults aged 25 years and the Expected Years of Schooling (EYSI) for children of school going-age. Data from UNESCO Institute of Statistics are normalized using zero as minimum value, and maximum of 15 years for MYSI and 18 years EYSI. National income per capita measures the standard of living dimension of the HDI. Minimum and maximum income is set at \$100 (PPP) and \$75,000 (PPP) respectively. Logarithm of income is taken to reflect the diminishing significance of income with rising GNI. Finally, geometric mean aggregates these three normalized indices into a composite index, the HDI.

Long run analyses of HCD in developing countries reveal that stagnation of life expectancy between 1990 and 2010, derailed potential of HDI of developing countries to catch up with that of other nations. Subsequently, this affected potential of economic development. For instance, as indicated in table 1, Kenya's HDI decreased between 1990 and mid-first-decade of 21st century. According to Escosura (2013), health-sector development in Africa was characterized by mismanagement, limited resources, medical research and establishment of modern medical facilities. The long run perspective analysis of HCD in Africa by Escosura (2013) found out that poor health-care result to high morbidity and mortality rates. These affect negatively the HCD and participation in economic activities. Low HDI is associated with low HCD. HDI ranges from 0-1, with 1 representing a country with perfect human welfare index.

Table 1.1: The growth and trends in Kenya’s three dimensions of HDI are shown in the table below.

	Life Expectancy at Birth	Expected Years of Schooling	Mean Years of Schooling	GINI Per Capita (2011 PPP\$)	HDI Value
1980	57.8	9.3	2.7	1,822	0.446
1985	59.5	9.2	3.4	1,727	0.459
1990	59.1	9.1	4.2	1,894	0.471
1995	56.0	8.7	5.1	1,760	0.463
2000	52.9	8.4	5.9	1,759	0.455
2005	54.7	9.7	5.9	1,856	0.479
2010	59.6	11.0	6.3	2,029	0.522
2011	60.4	11.0	6.3	2,072	0.527
2012	61.1	11.0	6.3	2,100	0.531
2013	61.7	11.0	6.3	2,158	0.535

Source: UNDP, 2015a.

HDI was established to profile the contribution of economic growth on the well-being of citizens. This was to ensure that economy growth leads to poverty alleviation, good education, health and nutrition care among others, and development of human capital to oversee economic development. Issues of sustainable development of the society according to the context of a community were major theme during the 1995 Copenhagen World Summit for Social Development (World Bank, 2013). The UN expected each region and nation to establish and implement programs that would ensure holistic economic growth and development. Many nations including Kenya embarked on a mission to develop human capital to enhance agricultural production among other economic development initiative. Agriculture was considered as the major sector in eradicating poverty, creating employment and source of income for many households. Aguna & Kovacevic (2011) stated that programs that promotes the general welfare of citizens promotes HCD in the agricultural sector considering farming is the main economic activity in the rural areas, where majority of poor people live.

Concern over the inability of rising rate of economic growth to promote welfare of citizens in developing countries, necessitated the UN to formulate various measures to ensure developing countries, undertake programs to improve welfare of its citizens and subsequently that of human capital. HDI was launched to measure improvement in human welfare, which was a measure of economic development. The implementation of MDG took the approach of promoting the livelihood of all citizens in developing countries, which was a paradigm shift from an approach that promoted growth of GDP as a measure of economic growth. Promoting agricultural productivity was considered one of main pillars of achieving economic prosperity in many developing nations. However, these economies were in dire need of healthy and educated citizens, who are free from poverty and hunger, to spur economic growth and development. According to WHO (2013), establishment of policies that promote HCD is necessary in achieving educated, health and desired workforce to take part in enhancing agricultural land-use intensification.

1.4 Promoting Human Capital Development

There are many efforts to promote HCD in Kenya. High proportions of the central government budget according to budget report analysis (2014) have over the years been allocated to finance programs aimed at promoting HCD. The devolved government system has incorporated similar objective of developing various aspects of an individual and the society, which produces economic value. It includes attributes such as knowledge and skills, health and nutrition status, which are accumulates from early stages of human life and lasting throughout one's life. The acquisition and accumulation of human capital overtime is what this research refers to as the HCD. HDI is a summary of composite

statistics of life expectancy (a health indicator), education (knowledge, skills and experience indicator) and per capita income (purchasing power and poverty indicator). Recent literatures argue that governments in developing countries have been encouraged to integrate malnutrition and poverty alleviation among programs for HCD (Barro & Lee, 2013). According to Bloom, Canning & Sevilla (2001), malnutrition and poverty hinders access to education, good health and proper nutrition, thus affecting HCD.

One of the objectives of promoting HCD was to augment the existing labour force in developing economies, with quality and efficient human capital. The quality and efficiency of the human capital would be achieved through increasing enrolment in formal education, reduction of mortality and morbidity rates and reduction of poverty. HDI is a measure of these three aspects of human welfare. The departure from evaluating the success of governments from GDP growth rate to human welfare benefits is supported by theories of welfare economist such as Pareto. The Pareto principle considers the 80-20 rule, which propagate that 80% of development comes from 20% of the population (Srinivasan, 1994). Agriculture being a major source of economic development in Kenya, it is necessary to promote HCD among individuals participating in agricultural activities.

1.5 Measuring Agricultural Land-use Intensification

Intensification is becoming a significant aspect of analysis in relation to increasing agricultural productivity. Relative huge yield gap have been recorded from different regions in Kenya. This is mainly due to differences in land-use intensification, which can be measured in three approaches. These approaches entail measuring the output per unit area of land per unit time, or measure of cropping frequency for a constant unit of land

area and time or a measure of contribution of inputs of capital, labor and skill on agricultural productivity (Dietrich et al 2010). The economic analysis of the influence of each factor of production on the agricultural output is an important effort towards increasing output per unit land-area and time, and forecasting and achieving food security and economic development. The current study utilizes the approach of measuring the contribution of long term development of human capital inputs towards intensification of agricultural land-use.

Issues of productivity per worker have played a central role in the analysis of growth of the agricultural sector. Per capita output in the agricultural sector has remained low over the years despite the increasing rate of literacy in Kenya. According to Nyoro (2002) and Tripp (2005), only 2% of courses offered in colleges and universities in Africa are agricultural based. Agricultural activities have been associated with pro-poor, whereby most farming is undertaken in the rural areas while limited crop and animal farming are undertaken in the urban regions. There is inadequate development of agricultural human resource in Kenya. This includes ensuring development of relevant information relating to agriculture and disseminating that knowledge to farmers, promoting the long-life and health-care of pro-farming regions and ensuring availability and access to farming finances.

TFP in the agricultural sector is the fraction of agricultural output not explained by the amount of input utilized in production. The level of TFP in the agricultural sector is determined by the technical efficiency and intensification of agricultural production inputs. Thus, this TFP measures both the technical efficiency & intensification of the agricultural land-use. However, effect of technical efficiency in the model will be

captured by the intensification of land-use since technical efficiency contributes to the level of intensification of agricultural land-use. The research will estimate TFP of the agricultural sector as a measure of intensification of agricultural land-use. Intensification of land-use has been closely associated with TFP in the agricultural sector, since intensification of agricultural factor-inputs results to growth in productivity not explained by conventional inputs of production. In this study, growth in agricultural productivity due to introduction of a new technology, practice or policy option is considered as the intensification of agricultural land-use. The growth results from improvement in the technical efficiency in farming *ceteris paribus*. Technical efficiency entails the effectiveness with which a certain amount of production inputs are utilized to produce maximum output.

1.6 Problem Statement

Kenya being an agricultural-based economy, has established various policy and programs to boost agricultural productivity and economic growth. However, over the years, Kenya has not attained food security because of low productivity of factor-inputs. Rate of adoption of modern methods of farming remains low compared to other sectors of the economy. Despite having among the best system of education in Africa, high literacy, among top 15 countries with good health-care system in Africa (WHO, 2013); these developments have not substantially enhanced HCD and hence productivity in the agricultural sector. There is growing need to determine the contribution of development of human capital on agricultural productivity, to guarantee return-on-investment in education, health and other programs aimed at improving agricultural land, labour and capital productivity. Despite development of various approaches to measure land-use

intensification, there are limited studies evaluating the variables that contribute to agricultural land-use intensification.

The current research looks into the contribution of HCD on the agricultural land-use intensification case study of Mwea irrigation Scheme. The study considers intensification of agricultural land-use to be a significant factor in promoting aggregate growth of the agricultural productivity. The researcher seeks to investigate whether overall development of human capital has an impact on the growth of the agricultural productivity. Previous researches have investigated the total factor productivity in relation to technological advancement. However, technical efficiency also affects total factor productivity. Nchare (2007) argued that technological advancement and technical efficiency are closely related concepts, which have a positive impact on agricultural productivity.

1.7 Research Objective

The general objective of this study is to evaluate the contribution of human capital development on the agricultural land-use intensification in Mwea irrigation Scheme, which is a measure of total factor productivity in the agricultural sector.

1.8 Specific Objectives

1. Establish HCD indicators that influence agricultural land-use intensification,
2. Estimate the contribution of HCD indicators on TFPg of Mwea Irrigation Scheme,
3. Recommend policy change to promote investment in HCD aimed at increasing intensification of agricultural factor-input.

1.9 Significance of the Study

Major consumers of this study include public and private agencies, households and individuals engaged in agricultural sector. The importance of developing an effective agricultural human capital will be emphasized in this study. The long run trajectory approach to HCD considered in this study and its impact on intensification of agricultural land-use will emphasise on the importance of developing policies, which promote long-term HCD to achieve continuous growth of agricultural productivity. The findings of the study will be of importance to public and private sector scholars and planners in education and health sectors, and government department dealing with improvement of human welfare as a stock of productive factor. The study contributes to the knowledge of the contribution of HCD into the growth of agricultural productivity.

1.10 Organisation of the Study

Chapter one contains the background of study, problem statement, objectives and the significance of the study, and it establishes information trends and emerging issues leading to this study. Chapter 2 is the analysis of theories, ideas and studies from various scholars in relation to the topic of study. Chapter three outlines the methodologies employed to undertake this secondary study. The chapter also highlights data-cleaning and analysis techniques to be applied in the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter presents an analysis of related literature. It starts by discussing various theories and ideas from scholars in different time-periods. This is followed by the analysis of different studies and finally is the overview of the discussion in this chapter.

2.2 Theoretical Review

2.2.1 Classical theories in Favour of HCD

Various schools of economic thoughts have attempted to define the broader concept of HCD as a significant tool for economic growth and development. Adam Smith's concept of division of labour focuses on specialization as a methodology of developing human capital, to perform specific production functions. The specialized skills are the wealth of nations, which fuels technological innovation and enhance efficiency in the agricultural production process, leading to surplus production. Many studies have modeled the contribution of human capital on agricultural land-use intensification on the surplus production resulting from augmented inputs of land, labour and capital. Ricardian model of comparative advantage argues that differentiation in agricultural labour productivity provides the benchmark through which countries determine their comparative advantage. Human capital development results to technological advancement, which plays a significant role in determining labour and capital productivity. On the other hand, human capital development is a functional-factor of technological advancement.

Many scholars have given considerable attention to the role of HCD on intensification of agricultural land-use. Schultz (1961) attributed agricultural output growth to factors beyond increase in arable land, man-hours and physical capital investments. Schultz argued that investment in HCD, mainly education and health, is significant in promoting agricultural factor-use intensification. Following the foundational work of Schultz, agricultural economics scholars and researchers have included human capital variable as an explicit factor of production. Among the areas of great concern was investigating how investment in HCD could enhance agricultural output of a unit-farm at the household level. Taylor & Yunez-Naude (2000) stated that HCD promoted productivity of household unit-farms, not necessarily due to acquisition of agricultural related courses or information, but due to general improvement in access to education, health and other social factors.

2.2.2 HCD and Agricultural Land-Use Intensification

According to Aggrey, Eliab & Joseph (2010), the assumption of human capital theory is that education increases worker's marginal physical product. This is a measure of the increase in unit output arising from additional knowledge and skills. Increase in marginal physical product of workers arises from among other factors, the increase in technical efficiency in the production process (Tegtmeier & Duffy, 2004). HCD enhances technical efficiency in the production, distribution and allocation of resources in the agricultural sector. Technical efficiency comes as a result of technological advancement or acquisition of knowledge and skills. On the other hand, health of an individual determines the amount of disposable energy and ability to engage in agricultural sector. Adoption of various farming methods, variety of crops and livestock and technological

changes have characterised transformation in the agricultural sector, thus promoting land-use intensification.

The need to achieve agricultural land-use intensification has created a demand for effective human capital and efficient agricultural production process. This includes demand for new knowledge, innovations and utility of emerging technologies when engaging in agricultural activities to increase output per unit piece of land. In order to achieve intensification of land-use, HCD is imperative. Human capital comprises of the stock of knowledge, behavior, personal and social attributes and innovation embodied in the ability and availability to perform labour in order to produce economic value. The knowledge and certain habits are developed through training while cultural practices influence particular personal and social attribute in relation to participating in agricultural economic activities. This includes the health of individuals and having sufficient energy to participate in agricultural activities (Cole & Neumayer, 2006; Gillespie, 2006). The integration between training, access to general education and good health, comprises the activities leading to HCD.

2.2.3 Interaction between Education and Agricultural Intensification

Improvement of knowledge base and modernisation of agricultural practice were considered by Yang & An (2002) and Riddell (2007) as significant factor in promoting agricultural land-use intensification. Efficiency of production process has been noted by Crook et al (2011) among countries and firms that encourage research and development to improve output per unit input. According to proponents of globalization, modernisation is the progressive evolution of ways and methods of engaging in the production process. It emerges from development of human capital with an aim of

promoting efficiency. Value addition in the agricultural production process takes place when contemporary ways and methods are applied in production activities. Eicher (2009) highlighted the need for continuous agricultural sector research and development, to improve existing knowledge base and develop modern methods of farming, managing and engaging in farming activities among other activities in the agricultural sector. This puts focus on the need for continuous investments education as a significant input towards intensification of land-use.

According to Hanushek & Woessmann (2008), enhancing workers capacity is positively related to agricultural land-use intensification. Agricultural land-use intensification is one of the measures of competitiveness of the sector and is increased by introducing new investment, knowledge and upward technological-based production efficiency. Agricultural land-use intensification is considered as a major indicator towards commercialization of agriculture and liberalization of market of agricultural produce. Analyzing the agricultural system from market level, promotes an efficiently-linked approach to engaging in agricultural activities from the farm to the market level. Commercialisation of agricultural systems and increased liberalization of trade necessitates for value addition in the sector, not only at the product market level but also the production process. At the production process level, value addition is achieved through greater capacity of agricultural workers. According to Yang & An (2002), knowledge of the expected market-value and quantities of farm produce, helps stakeholders to develop capacity of individuals and systems to achieve intensification of land-use. HCD promotes the achievement of increased outputs with limited factor inputs,

thus helping to optimise production and overcome the problem of extensification (Nin et al, 2003).

According to Gul et al (2009) and Schultz (2003), agricultural land-use intensification is created by individual workers participating in agricultural activities, when there is growth of innovation. Growth of innovation is not directly related to years of schooling, but Oreopoulos (2006) argued that years spent in school, health of households and living standards, enhances workers creativity and level of innovation. Experience and continuous agricultural research contribute to value addition in the agricultural sector. Increase in productivity when the conventional factor-input of capital, labour and land are held constant, was considered by Helfand & Edward (2004) and Bernstein and Woodhouse (2010) as the intensification of land-use. Gross value added has been used by different studies as a tool for measuring land-use intensification. Scarcity of statistical data is the main reason of using this methodology, to derive changes in agricultural productivity due to changes in human capital.

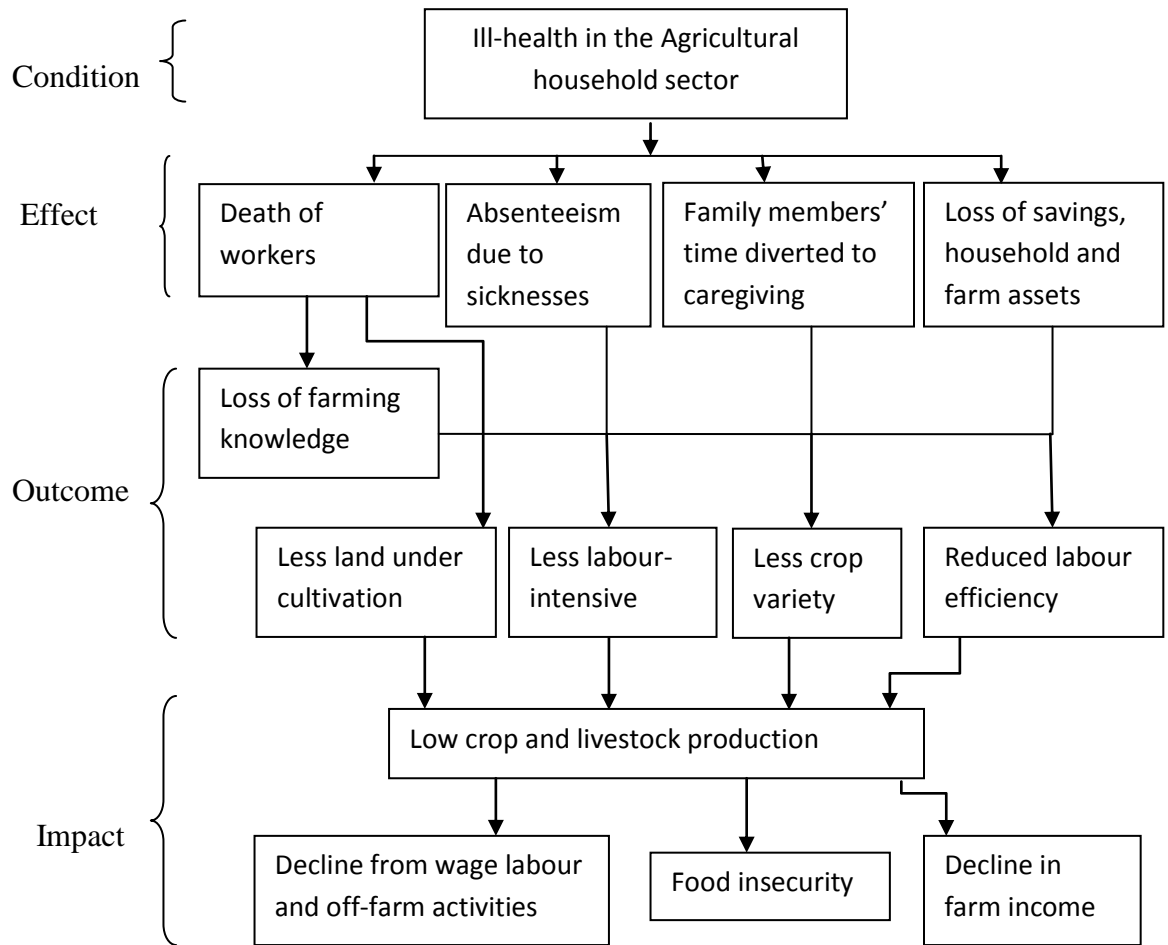
2.2.4 Interaction between Health and Agricultural Intensification

The causality between agricultural productivity and health of the population are a major area of research, especially the forward and backward linkage between agriculture and health of rural households. Major concern focuses on agriculture as a source of food to provide nutrient and energy needs for the agricultural labour. However, in the recent past, studies have focused on the effect of ill-health on growth in agricultural productivity. According to an IFPRI funded study by Asenso-Akyere et al (2011), ill-health has three broad impacts on the agricultural land-use intensification. Morbidity results to absenteeism from work while the eventual death leads to long term loss of farming

knowledge, which has various negative externalities that reduces agricultural land-use intensification. Ill-health causes the diversion of farming time towards caring for the sick family member, leading to deteriorating livelihood of the farming population. Finally, according to Cole & Neumayer (2006), ill-health leads to loss of savings and other property in dealing with resultant diseases and its consequences. The three broad impact of ill-health diverts resources that could be utilised for agricultural investment resulting to diminishing productivity per unit input.

Good health is both consumption and an investment asset, which has a compounding return on agricultural unit inputs. According to figure 1, Ill-health triggers a cycle of declining agricultural land-use intensification and poor health. In order to mitigate the cyclic impact of health problems on agricultural productivity, Negin (2005) and Jayne et al (2005) suggested investment in programs that promote people's livelihood. When assessing the economic impact of HIV/AIDS on agricultural productivity in Africa, Negin argued that investment in health care necessitate for investment in adequate livelihood. Poverty was considered a major cause of ill-health among African communities. According to Russell (2004), improvement of livelihood of the population promoted health care in different communities in Africa. Asenso-Okyere et al. (2009) and Yamano and Jayne (2004) stated that promotion of health care reduced the mortality rate of working-age adults, thus increasing small-scale farm intensification. According to IFPRI (2013) study, adequate livelihood includes appropriate inputs such as a general knowledge, land, bio-intensive farming implement and practice, remunerative market and income flow. Thus, adequate livelihood is a major determinant of agricultural land-use intensification.

Figure 2.1: Conceptual framework for the impact of illness/disease on agricultural land-use intensification



Source: Adapted from Negin (2005) and Asenso-Okyere et al. (2009).

2.3 Empirical Review

Dietrich et al (2012) study revealed that agricultural land-use intensification is a factor of human-induced augmentation of yield. They argued that although this yield caused by human activities is not a full measure of land-use intensification, human-induced amplification of yield cannot be ignored. The study used an aggregated factor to estimate the proportion of agricultural land-use intensification caused by human activities. The model could not measure contribution by human activity directly. It was designed to deduct total factor productivity from the separate contribution of capital, labour and land, following a growth accounting model. According to Fulginiti, Perrin & Yu (2004), development and enhancement of human capital through research and development, improving managerial skills and innovation are considered as imperative factors towards promoting agricultural productivity per unit input. Dietrich et al (2012) study demonstrated that human capital development enhanced the effectiveness of utilized ordinary factor inputs, resulting to increased agricultural output per piece of land.

A study by Piot, Greener & Russell (2007) investigated the incidence of endemic to poor economic development, and the cyclic effect of low human capital development on Africa's economy productivity. The study found out that ill health has a long-run direct negative effect on output per unit factor of production. According to the study, variety of indicators shows that ill health is prevalent among developing countries, resulting to diminishing productivity per households. Poor health minimizes people's engagement in economic activities, which results to declining individuals and households' productivity. While examining this view, Piot et al. (2007) claimed that the impoverished and deprived society is at high risk of endemic prevalence, thus hindering their engagement in

economic activities such as farming. This is because affected households spend time and resources taking care of the sick members. Using the 2006 economic data, they found that countries with high Gini coefficient had high prevalence of endemic in SSA, which illustrates the link between life expectancy and poverty, as a result of low productivity over-space.

A study by Pinckey (1996) to evaluate the impact of human capital on agricultural productivity used a modified Cobb-Douglas production function, to compare effect of human capital development on household productivity in Kenya and Tanzania. Pinckey's study tested basic literacy and numeracy skills. The study found out that having at least one person educated in the household, raised output by about 30% irrespective of whether or not that person was the agricultural decision maker. According to the findings of the study, the significance of general education on agricultural land-use intensification relates to the fact that educated agricultural decision maker could understand recommendations by the district agricultural officer. The tested extension service recommendations included reading farming instruction and stating the correct values for fertilizer use on various crops, spacing and spraying various crops. However, the study produced some unexpected results. For instance, a 19% reduction in output was recorded in some households, which had decision maker who had attended primary school, holding constant the cognitive skills and presence of other educated persons. Private and public expenditure on education investment had a positive impact on agricultural land-use intensification in both countries.

Wouterse (2014) case study was an empirical test of whether human capital was a technology changing variable in agricultural production. This case study of Burkina Faso

found out that HCD was a significant driver of agricultural land-use intensification. The study estimated an augmented stochastic frontier using OLS estimator, to assess the role of HCD on agricultural productivity at the farm household level. The regressed equations were models specifying the slope and intercept of an augmented Cobb-Douglas production function. Coefficient of input variables represented the elasticities of output in relation to each input, which was a measure of land-use intensification at the household level. Household health, energy consumption and investment in education had a significant positive impact on output growth, indicating their capacity to obtain TFP similar to technological advancement (Coelli & Rao, 2015). However, there were mixed results whereby some households recorded negative causal correlation between HCD and agricultural productivity. Wouterse argued that this was due to low attendance to formal education among old household members.

A research study to assess the effect of human capital on agricultural productivity and income of farmers by Djomo & Sikod (2012), found out that additional level of education and years of experience promoted TFP, thus agricultural land-use intensification. Data from a survey of 4275 Cameroonian household was used in the study. A linear form of Cobb-Douglas model production function was employed in the estimation of the relationship between human capital development among other explanatory variables and growth of agricultural output. There was an exponential growth in the value of agricultural output. Apart from ordinary factors of production, the exponential growth was determined by a residual component, which captured technological improvement. The technological growth results from development of human capital. Improvement of technology achieves similar outcome in the production process as the technical

efficiency. The two are factors of HCD, which according to Ukoha (2000) increase production per household.

Study by Aggrey Eliab & Joseph (2010) employed a translog functional form and a modified Cobb-Douglas production function to analyze the contribution of human capital to productivity of labour. The study found a positive correlation between human capital and output per unit input. Average education, training and education of manager were the determinant of contribution of labour into TFP. For instance, Kenyan firms that adopted a cultural of employee training exhibited significant high labour productivity than firms without the training. The Cobb-Douglas was derived from the linear transformed model by restraining second order terms coefficients of the translog to zero. General least square was used for estimating the function. High percentage of training and skilled workers was positively related to increasing contribution of labour into the TFP. The study concluded that investment in various human capital indicators was critical in increasing productivity and competitiveness of firms in Sub-saharan Africa.

2.4 Overview of Literature Review

According to the literature review, HCD has a considerable positive impact on intensification of agricultural land-use. Education promotes acquisition of new knowledge and skills, which plays a significant role in enhancing the effectiveness of human capital. Technological development has a causal relationship with education, which raises the efficiency of agricultural production process thereby intensifying land-use. On the other hand, good health promotes the energy and physical availability of productive agricultural labour, thus raising agricultural productivity. Previous empirical studies employed a modified Cobb-Douglas production function to estimate contribution

of different aspects of HCD on the agricultural productivity. The current study employs similar model specification, but takes two unique approaches. First, this study considers the effects of annual economic growth on HCD, and the extent in which this holistic development influences agricultural productivity. Second, the study measures agricultural productivity in relation to intensification of agricultural land-use, which is a measure of contribution of inputs of capital, labor and skill on agricultural productivity. Thus, the study uses a modified production function to estimates the growth TFP of the agricultural sector as way of measuring the intensification of agricultural land-use.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This section discusses the methodologies utilised to carry out this secondary study. It highlights data-cleaning and analysis methods to be applied in the study. Previous literature has revealed that HCD contribute significantly in the growth of agricultural productivity. Various methodologies have been utilized to measure this impact of HCD. Key to them is the use of neoclassical production function models to measure the impact of various component of HCD, mainly education and health, on the growth of TFP.

3.2 Economic Model

The neoclassical growth models emphasize the significance of technological advancement to the economic growth. Technology is considered as a factor that augments the effectiveness of conventional factor-input and the efficiency of the production process. Various economic models show the relationship between output levels, stocks of capital, labour-time and the total factor productivity. According to Coelli & Rao (2005), growth of TFP measures the contribution of technical advancement, knowledge and the general development of human capital to the economic growth. Therefore, the presence of this factor in an economic equation is to estimate the effectiveness and efficiency of factors of production and the production process respectively. One of the neoclassical growth models according to Romer (2011) is the Solow-Swan growth model.

This research will utilize Solow Growth Accounting Model to decompose agricultural output growth into growth due to capital stock, input of labour and total factor productivity.

Depicted in a production function below

$$Y_t = F(K_t, L_t, A_t) \dots \dots \dots 1$$

Thus, growth is a function of standard input-factors K & L and an augmenting factor A. The interest of this study is to evaluate the growth of output due to the augmenting factor, which is a residual factor. To find the output growth, we differentiate equation 1 with respect to time.

$$\Delta Y_t = F_K K_t + F_L L_t + F_A A_t \dots \dots \dots 2$$

Finding the equation for growth rate: We divide both sides by the output and then manipulate

$$g_y = (F_K K_t / Y_t) g_k + (F_L L_t / Y_t) g_l + \underbrace{(F_A A_t / Y_t) g_a}_{TFPg} \dots \dots \dots 3$$

Assuming capital and labour are traded at a price equal to their marginal product (competitive market-price is equal to marginal product), of **b** & **c** respectively. Equation 3 becomes:

$$g_y = (b K_t / Y_t) g_k + (c L_t / Y_t) g_l + TFPg \dots \dots \dots 4$$

Hence,

$$\text{Capital share of national output is given by } \partial_K = (b K_t / Y_t) \dots \dots \dots 5$$

$$\text{Labour share of national output is given by } \partial_L = (c L_t / Y_t) \dots \dots \dots 6$$

Therefore, from equation 4:

$$TFPg = g_y - \{ \partial_K g_k + \partial_L g_l \} \dots \dots \dots 7$$

Hence, growth in TFP is a residual in the growth accounting model, that is, the Solow residual. Solow residual is thus a measure of growth, which is not accounted for by changes in the standard production factors.

From equation 7, one can compute the value of TFPg if given a number of observed output, the respective factor-inputs of capital and labour corresponding to the outputs and share of each standard input-factor to the output. Index approach is used for estimating TFPg in agricultural research, since output, input and factor-share in output are known.

3.3 Empirical Model

The model of analysis that includes all variable is described below

$$\text{TFPg} = f \{ \text{Education, Health, Income, Land} \} \dots\dots\dots 8$$

The relationship between variables is illustrated in the regression model below

$$\text{TFPg} = \alpha + \beta_1 \text{Edu} - \beta_2 \text{Health} + \beta_3 \text{Income} + \beta_4 \text{Land} + e \dots\dots\dots 9$$

Where:

TFPg is Growth of Total Factor Productivity

Edu is Rate of Enrolment in Primary School

Health is Rate of Hospital Re-attendance/Revisits

Income is the amount paid to Mwea Irrigation Scheme Plot holder

Land is the number of Hectares of Mwea Irrigation Scheme

α - Constant to be determined

β_i - Coefficient of the explanatory variable

e - Error Term

3.4 Variables

Total Factor Productivity growth (TFPg) is the Solow's residual in the growth accounting model and will be the dependent variable in this study. The research will evaluate how various non-conventional input variables contribute to growth of TFP of Mwea Irrigation Rice output. These factor-inputs are the explanatory variable in this study, which are not captured in the conventional production function. They include Education, Health, Income and Land data from 1980-2013. Input and output data were obtained from Ministry of Agriculture, National Irrigation Board and KNBS.

Education is positively correlated to the growth of TFP. It entails acquisition of general knowledge through formal and informal schooling, and for the purpose of this study, agricultural research and development to enhance farming practice and technologies and the access to farming information. KNBS data on the number of pupil who attended primary school in Kirinyaga district was used.

Health and growth of TFP have a negative correlation. Health comprises of access to affordable medical care, eating balanced diet, clean water and other social amenities. Availability and consumption of enough food components plays a key role in determining the health of individuals. Ill-health is measures by rate of morbidity; amount spent on treatment, time wasted taking care of the sick and lost farming hours due to sickness. KNBS data on the number of patients who revisited hospitals in Kirinyaga district was used.

Income is positively related to TFPg since it promotes access to modern farming inputs and agricultural investments. Income comprises of all revenue from salaries and

investments. For the purpose of this study, income was considered as revenue collected from farming activities. Data from National Irrigation Board and KNBS on the amount of money paid to Mwea Irrigation scheme plot holder was used.

Land resource positively influences TFPg by providing opportunities for expansion of farming activities. Data from KNBS on the number of hectares under Mwea irrigation scheme was used in this study.

3.5 Estimation and Hypothesis Testing

The study will utilise a time series regression model to evaluate the contribution of HCD on agricultural land-use intensification in Kenya. A time series approach was preferred due to spurious regression produced when standard OLS method is applied to non-stationary data series. According to Inder (1993), OLS regression can result to high R-squared, significant t-value and low DW test results of the estimated coefficients. This would imply a significant dependent-explanatory variable relationship, when they are entirely unrelated.

Error Correction Model (ECM) will help to solve the problem of spurious relationship as the study retains the level of information. Alternative approach is the co-integration approach developed by Engle and Granger (1987) and latest improved by Johansen (1990). However, this co-integration approach is appropriate for stationary data of the same order of integration. Conversely, According to Hendry (1995), ECM method is appropriate for data series of different order of integration.

3.6 Data Analysis

3.6.1 Normality Test

The first step of data analysis will be to check for data normality by carrying out skewness and kurtosis tests, and the jargue bera normality test. Decision to convert data into log form or not will be made at this step.

3.6.2 Unit root Test

Each variable will undergo unit root test. However, the study will ensure a state of stationary is reached by conducting unit root test. First differential will be computed for non stationary data series in case there is a combination of stationary and non stationary data series (Nelson & Plosser, 1982). In order to test the time-series properties of data series, the study will utilise the Augmented Dickey-Fuller (ADF) test. ADF will help in testing the null hypothesis of non-stationary of data series against the alternative hypothesis of stationary data series. However, p-perron tests can also be employed in unit roots testing.

The following are the hypothesis assumed by ADF and p-perron test

H_0 : The variable is non stationary (variable has a unit root)

H_1 : The variable is stationary (variable has no unit root)

3.6.3 Testing for Co-integration

The study will test for the presence of cointegrating relationship among variables once unit root test (3.6.2) has verifies all data series has reached stationary level. Cointegration tests for data series will help to establish long run relationships. The two steps Engel Grander method entails generating residuals from the long run non stationary variables

equation. To test for cointegration of variables, ADF and PP test are applied to establish stationarity of the residuals. Short run and long run relationship of variables exist if the residuals are stationary at levels. Conversely, cointegration test using Johansen (1990) approach is considered more accurate and strong (Johansen, 1990). The method requires appropriate lag length, which are determined by the Schwarz criterion, be known.

3.6.4 Error Correction Model (ECM)

This stage involves estimating the causality relationship between variables once cointegration test (3.6.6) has established long run relationship among variables. In order to establish this, all data series should be stationary. In addition, cointegration testing will be conducted first and the cointegration residual will be used to generate an error correction term (ECT). The sign of the ECT coefficient will help in the conclusion of the direction of causality.

ECM minimizes chances of estimating spurious relationship without losing the long run information. According to Hendry (1995), under the ECM approach the lag structure is not arbitrarily restricted. In addition, even when endogenous explanatory variables exist, ECM provides estimates with valid t-statistics (Inder 1993). Note that Granger causality tests will be employed instead of ECM, if no cointegrating equations exist.

CHAPTER FOUR
DATA ANALYSIS

4.1 Introduction

The purpose of the study was to estimate the contribution of various indicators of human capital development on the agricultural land-use intensification. Mwea irrigation scheme was taken as the case study.

4.2 Descriptive Statistics

4.2.1 Measures of Dispersion or Spread of the Series

The normality tests coefficients presented in table 4.1 shows measures of dispersion or spread of the data series. The mean and median identifies the relative frequency distribution center.

Table 4.1: Measures of Dispersion of the Series

	TFPg	Edu	Health	Income	Land
Observations	33	33	33	33	33
Mean	0.2925	0.0102	5.669	566.0	7611
Median	0.1505	0.0135	0.0321	178.0	6052
Maximum	3.858	0.1638	187.2	2793	15800
Minimum	-0.8522	-0.1429	-0.9914	20	5771
Std. Dev.	0.7338	0.0562	32.58	749.2	2437
Skewness	0.0000	0.3434	0.0000	0.0010	0.0017
Kurtosis	0.0000	0.0172	0.0000	0.0866	0.0364
Probability	0.0000	0.0475	0.0000	0.0040	0.0034

Stata12 Computations

While the mean presents the series average value divided by number of observation, median is the series' middle value, when we order the series in an ascending or descending order. Apart from health values, the median and mean are relatively near each other, thus minimizing cases of outlier problems. The standard deviation estimates the spread or dispersion of the series.

Other measures of dispersion of the data undertaken in the study are skewness and kurtosis. Values close to zero indicate normal distribution (zero skewness value shows symmetric distribution of the data with normal distribution ranging from -1 to +1. Kurtosis indicates the peakedness of the data series. The shape of TFPg and Health data distribution quantifies a Gaussian distribution identified by a Kurtosis of 0.0. The other variables have a positive peak (leptokurtic). The Kurtosis and skewness tests are conclusive, whereby the coefficients indicate all variables are normally distributed. Thus, the study did not undertake Jarque-Bera test or convert data into log forms.

4.2.2 Multicollinearity Test

Table 4.2: Multicollinearity Test Results

	TFPg	Edu	Health	Income	Land
TFPg	1.0000				
Edu	0.1830	1.0000			
Health	-0.0621	0.1358	1.0000		
Income	0.0096	-0.0266	0.3892	1.0000	
Land	0.0554	-0.0756	0.2216	0.6330*	1.0000

Source: Stata Computation *Relative correlation Observations 33

The correlations coefficient in table 4.2 indicated all variables, apart from correlation between income and land, have low correlated such that they wouldn't bring the problem of multicollinearity. Theoretically, household's farming land-size and income from farming activity have a lagged correlation. The land-size in a previous year determines ones farming investment and thus income in that year. Similar relative correlation exists between health and income. Both Health and income will be lagged to impose a general structure upon the estimated coefficients' relative values.

4.3 Statistical Analysis

4.3.1 Unit Root Test

The first step for statistical data analysis entailed testing for stationarity of the series data. All variables in the model were tested for stationarity trends, and if they were nonstationary, the study established the order of integration.

Table 4.3: ADF Test for Stationarity

	ADF	1%	5%	10%	Z(t)	Comment
TFPg	-6.718	-3.702	-2.980	-2.622	0.0000	Stationary
Edu	-5.631	-3.702	-2.980	-2.622	0.0000	Stationary
Health	-5.717	-3.702	-2.980	-2.622	0.0000	Stationary
Income	1.341	-3.702	-2.980	-2.622	0.9968	Non-Stationary
Land	-3.079	-3.702*	-2.980	-2.622	0.0282	Stationary

Number of Observations =32

*Source: Stata computation *non stationary*

Table 4.4: Phillips-Perron Test for Stationarity

	PP	1%	5%	10%	Z(t)	Comment
TFPg	-35.66	-17.68	-12.72	-10.34	0.0000	Stationary
Edu	-31.08	-17.68	-12.72	-10.34	0.0000	Stationary
Health	-32.82	-17.68	-12.72	-10.34	0.0000	Stationary
Income	4.920	-17.68	-12.72	-10.34	1.0000	Non-Stationary
Land	-16.52	-17.68*	-12.72	-10.34	0.0245	Stationary

*Number of Observations =32**Source: Stata computation *non stationary***Table 4.5: ADF Test for Stationarity after first Difference (Lag length=1)**

	ADF	1%	5%	10%	Z(t)	Comment
TFPg	-9.864	-3.702	-2.980	-2.622	0.0000	Stationary
Edu	-9.999	-3.702	-2.980	-2.622	0.0000	Stationary
Health	-9.444	-3.702	-2.980	-2.622	0.0000	Stationary
Income	-6.762	-3.702	-2.980	-2.622	0.0000	Stationary
Land	-10.81	-3.702	-2.980	-2.622	0.0000	Stationary

*Number of Observations =31**Source: Stata computation*

Table 4.6: Phillips-Perron Test for Stationarity after first Difference (Lag length=1)

	ADF	1%	5%	10%	Z(t)	Comment
TFPg	-39.65	-17.68	-12.72	-10.34	0.0000	Stationary
Edu	-45.14	-17.68	-12.72	-10.34	0.0000	Stationary
Health	-40.12	-17.68	-12.72	-10.34	0.0000	Stationary
Income	-51.95	-17.68	-12.72	-10.34	0.0000	Stationary
Land	-46.90	-17.68	-12.72	-10.34	0.0000	Stationary

Number of Observations =31

Source: Stata computation

4.3.2 Test for Cointegration

4.3.2.1 Engel-Granger two step Test

Following the unit-root test of variable in the previous section and establishing all variables are of the same order of integration, I regressed the model for the long run relationship. Residuals were generated. Figure 4.1 is a graph drawn from the generated residual against time (year).

4.3.2.2 ADF Test for Cointegration

The lagged residual were tested for stationarity using ADF test. The null hypothesis is accepted when test results indicate presence of unit root (non stationarity of the residual).

Figure 4.1: Graph of Residual vs. Year

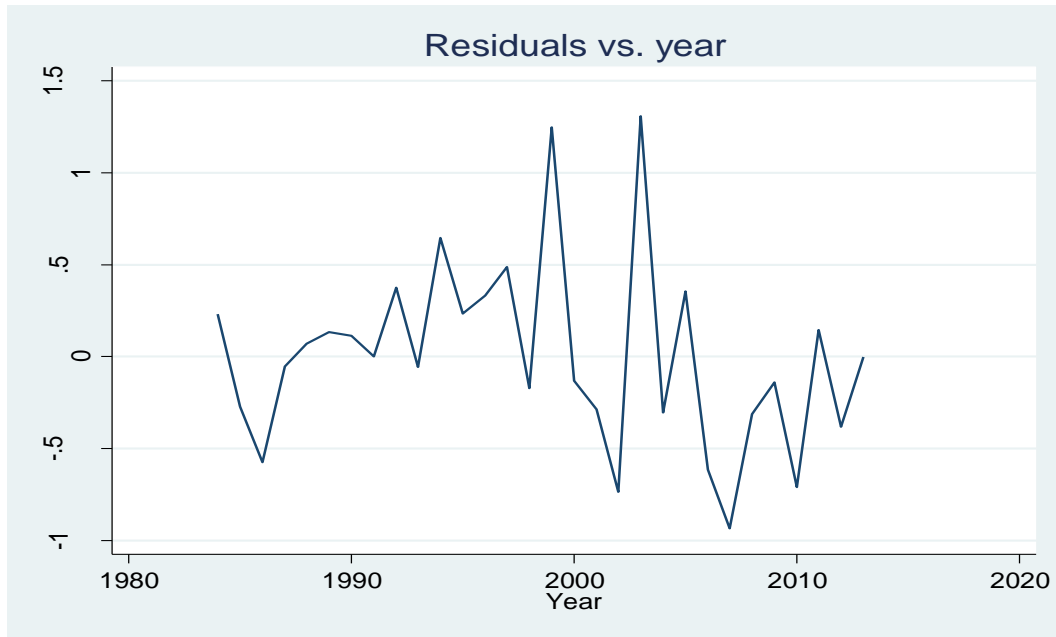


Table 4.7: ADF Unit root test results for the residual

	ADF	1%	5%	10%	Z(t)	Comment
Z(t)	-5.967	-3.701	-2.980	-2.622	0.0000	Stationary

Source: Stata computation

The absolute value of the test statistics is greater than the absolute values of critical values at all critical interval. The ADF unit root test indicates the lagged residual have no unit root, thus null hypothesis is not accepted. This implies short run relationship of variables exists. These results also indicate cointegration exist among the long run variables, implying that the variables converge to a long run path (or equilibrium).

$$H_0: \beta_i = 0$$

$$H_1: \beta_i \neq 0 \quad \text{where } \beta_i = \beta_1, \beta_2, \beta_3, \dots$$

4.3.3 Error Correction Model

ECM helped to estimate direction of causality among variable since cointegration equations exist. Cointegration test of the residual in the previous section revealed stationarity of the variables. Short run and long run relationship of variables was also established.

Therefore, the OLS regression results are indicated below

Table 4.8: Model Regression Results

	Coefficient	Std. Error	t-value	p> t	95% Confidence Interval	
					Min	Max
Edu	3.882754	1.802167	2.15	0.041	0.1711206	7.594387
Health	-0.008281	0.0036086	-2.29	0.030	-0.0157131	-0.0008489
Income	-.0018423	0.0005986	-3.08	0.005	-0.0030751	-0.0006094
Land	0.0002342	0.0000449	5.21	0.000	0.0001417	0.0003267
Constant	-1.413502	0.3512281	-4.02	0.000	-2.136869	-0.6901339

Source: Stata computation

Number of Obs =30

F (4,25) =7.76

Prob >F = 0.0003

R-Squared = 0.5540

Adj. R-Squared = 0.4826

Root MSE =0.5533

The model for growth rate of total factor productivity would be

$$\text{TFPg} = -1.413502 + 3.882754 \text{ Edu} - 0.008281 \text{ Health} - 0.001823 \text{ Income} + 0.0002342$$

Land

From the regression results, the R-squared of 0.5540 imply that the explanatory variables explain 55.40% of the rate of change of total factor productivity. The remaining 44.6% is explained by variables not captured in the model. The Adj R-squared considers the degree of freedom, that is, $n-k-1$, thus it is less than R^2 as usual. Even when a new explanatory variable is introduced in the model, Adj R^2 shows that only 48.26% of growth of total factor productivity can be explained by the explanatory variables. A negative constant value of 1.413502 indicates that in the absence of the included variables, rate of change of TFP would be negative. The probability ($\text{prob}>F$) entails the P-value associated with calculated F-statistics, and is used for testing the hypothesis. In this case, the F-statistics are within the range under which null hypothesis is rejected. This indicates all variables in the model are statistically significant to explain the rate of change of total factor productivity, despite the small magnitude of some coefficients.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Introduction

The study aimed at estimating the contribution of human capital development on agricultural land-use intensification, a case study of Mwea Irrigation scheme. From the previous chapter, this chapter discusses the summary of findings, conclusion of the regression results, policy implication of the findings, limitations of the study and areas of further research.

5.2 Summary of Findings and Conclusion

Overall, all the HCD indicators taken as the model's explanatory variables, explained 55.4% of the growth in total factor productivity of the agricultural sector. All the variables were normally distributed with close mean and median, indicating absence of outlier problem. In addition, all the variables were significant to the model, with F-statistic below 0.05 at 5% level of significance. Education indicated a positive influence on the growth of total factor productivity. When other variables are held constant, a change in education by one unit leads to positive change of agricultural land-use intensification by 3.882754. The study findings show that education is an imperative HCD indicator, which has a significant influence on the growth of TFP of the agriculture sector. According to the descriptive statistics, education is positively skewed showing its importance in the growth of agricultural productivity.

Health variables measured the effect of high morbidity rate on the growth of TFP. Ill-health identified by one individual revisit to hospital, would result to marginal decline in

agricultural land-use intensification by 0.008281, when other variables are held constant. Hospital revisits signals prolonged time of illness, which indicates lost time to engage in farming activities and a lot of resources were used for treatment instead of agricultural investment. Surprisingly, rise in income by one unit, all other variable held constant, would result to decrease in agricultural land-use intensification by a marginal value of 0.001823 according to the model. Income gives a different direction of relationship with TFPg, not expected in the study. This could be explained by rural-urban migration due to rising income from farming or alternative investment following increase in income from farming activities. Finally, increase in land by one hectare leads to a marginal increase in agricultural land-use intensification. Land was taken as a control variable.

5.3 Policy Implication

According to the study, development of human welfare variables contributes significantly to the growth of agricultural productivity. Education includes acquisition of general knowledge through formal and informal schooling, and according to Tripp (2005), access to farming information and agricultural research and development to improve farming practice and technologies. Public policy makers ought to ensure strategic investments in education, to guarantee exponential growth. This implies that with every unit investments in any education indicator, there will be a more than proportionate intensification of agricultural land-use, thus growth in agricultural output. Both public and private investment in different areas of education is important for HCD, since these results to rising agricultural productivity for individual investors and the community.

According to the findings of the study, ill-health contributes negatively to the agricultural land-use intensification. Ill-health results to loss of farming hours as individuals spend time taking care of the sick relatives, the sick individuals cannot work thus farming labour is wasted and household resource meant for agricultural investment is spend on treatment. Various level of government should allocate resources to the health sector, to improve health condition of the citizenry especially in the rural areas where farming is mainly undertaken. Access to modern health care, clean water and social amenities improves human welfare, thus improvement in HCD.

Public awareness is imperative to ensure people have knowledge of their health and nutritional needs, and areas of priority to the government. This will ensure collaboration of all stakeholders in achieving a health nation, which could contribute to among others agricultural land-use intensification. Healthy people have the energy and strength to engage in productive farming practices. Food security and access to nutritional diets contributes to good health. A cyclic effect exists whereby well-fed individuals contribute to diversification of crops and animal products and contributes to growth in agriculture output. This guarantees access to balanced diets and food security. There should be consented effort on the part of all levels of government and other stakeholders, in the implement of policy guidelines such as the Kenya's National Nutrition Action Plan (2012-2017) stipulated eleven strategic objectives (Republic of Kenya, 2012).

Creating and maintaining attractiveness of farming and other agricultural ventures is significant in attracting and growing agricultural investments (Steinfeld & Danford, 1999). Rising farming income indicates reduction in poverty and access to better

education and health care. Besides, rising incomes results to high savings thus, more investment. Contrary to the expectation, the findings indicated growth of agricultural TFP is negatively related to increase in farming income. The negative correlation may arise from farmers choosing alternative investment once they achieve desired level of savings from farming investments. In addition, high income from farming may encourage rural-urban migration and thus reduction in farming labour and investments. Public policy makers ought to guarantee good market conditions such as availability and access to market and good price for farm produce, to attract especially youths to engage in agribusiness and maintain growth of farming investments.

5.4 Limitations of the Study

There were challenges in finding previous literature that analyzes contribution of development in human welfare on agricultural land-use intensification. National HDI data produced insignificant results, necessitating the change to rural data. Rural human capital development indicators and HDI data were unavailable, thus the study adopted HDI disaggregated data of education, health and income. Data for education and health HDI indicators for Mwea Scheme were unavailable; instead former Kirinyaga district data were used as proxy. Both national and regional agricultural data are scarcely available, which was an impediment in the computation of agricultural TFPg. Finally, the different base-years and currency used to record KNBS data necessitated for harmonization of the time series data using ratio and tread-based estimation.

5.5 Further Areas of Study

The study concentrated on estimating the contribution of HCD on one measure of agricultural land-use intensification. Apart from the growth in productivity as a measure of agricultural land-use intensification evaluated in this study, researcher should evaluate the effect of HCD indicators on the other two measures of agricultural land-use intensification.

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APPENDIX 1

year	tfg	edu	health	income	land
1981	0.242424	-0.0096	0.03214	21	5771
1982	0.146341	0.013183	0.041479	35	5782
1983	0.510638	0.058459	0.070013	36	5784
1984	0.183099	0.000969	0.112152	44	5820
1985	-0.02381	0.080218	-0.49069	41	5825
1986	0.02439	0.018176	-0.04642	29	8271
1987	0.071429	0.039183	0.094886	50	5799
1988	0.033333	0.015904	0.065031	54	5795
1989	0.150538	0.02011	0.144005	65	5818
1990	0.046729	0.000902	-0.10778	65	5820
1991	0.008929	0.016515	0.156115	62	5802
1992	0.433628	0.026382	-0.09295	81	5815
1993	-0.08642	0.013212	-0.2224	92	5846
1994	0.601351	0.002938	-0.19883	134	5882
1995	0.168776	0.01201	-0.06127	143	5878
1996	0.274368	-0.00206	0.70993	231	5901
1997	0.232295	-0.03044	-0.49762	286	6145
1998	-0.25747	0.007656	-0.10017	178	6000
1999	1.21362	-0.06324	-0.11257	20	6052
2000	0.855944	0.024494	0.048658	215	8617
2001	-0.06707	-0.1253	-0.01264	349	10590
2002	-0.85218	0.032868	-0.12862	426	6054
2003	3.85792	0.104125	0.07392	573	15800
2004	0.406074	0.013595	1.27179	897	10000
2005	0.4288	-0.06605	0.217815	1066	10000
2006	-0.00616	-0.01963	-0.23509	1009	10332
2007	-0.13014	0.039929	0.101781	919	8325
2008	0.373705	0.026008	-0.58342	1450	7806
2009	-0.15983	0.16376	1.50494	1341	7431
2010	0.604938	0.014887	-0.99139	2080	10526
2011	0.038462	0.050816	187.159	2197	10629
2012	-0.05455	-0.14287	-0.91592	1728	10629
2013	0.381766	0.000267	0.058488	2793	10629

APPENDIX II

1. Human Development Index Computation

The HDI is a summary measure of average achievement in key human development dimensions computed as follows:

Life Expectancy Index (LEI)

Life expectancy at birth assesses the health dimension. LEI is calculated using 20 and 85 years as minimum and maximum values respectively.

$$= \frac{LE - 20}{85 - 20}$$

Education Index (EI)

Education index is calculated by combining two indices using arithmetic mean. These indices are MYS for adults aged 25 years and the EYS for children of school going-age. Data from UNESCO Institute of Statistics are normalized using zero as minimum value, and maximum of 15 years for MYSI and 18 years EYSI

$$= \frac{MYSI + EYSI}{2}$$

a. Mean Years of Schooling Index (MYSI)

$$= \frac{MYS}{15}$$

b. Expected Years of Schooling Index (EYSI)

$$= \frac{EYS}{18}$$

Income Index (II)

National income per capita measures the standard of living dimension of the HDI.

Minimum and maximum income is set at \$100 (PPP) and \$75,000 (PPP) respectively.

Logarithm of income is taken to reflect the diminishing significance of income with rising GNI.

$$= \frac{\ln(\text{GNIpc}) - \ln(100)}{\ln(75,000) - \ln(100)}$$

Finally, geometric mean aggregates these three normalized indices into a composite index, the HDI.

$$\text{HDI} = \sqrt[3]{\text{LEI} \cdot \text{EI} \cdot \text{II}}$$