BARRIERS AND ENABLERS TO UPTAKE AND IMPLEMENTATION OF SYSTEM OF RICE INTENSIFICATION

A Case Study of Mwea Irrigation Scheme in Kenya

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A mini-thesis submitted in partial fulfilment of the requirements for the degree of Master of Science (Climate Change and Development) in the Department of Environmental and Geographical Science at the University of Cape Town

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KEYWORDS

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ABSTRACT

It already seems preposterous to be able to sufficiently meet global food demand of the expected nine billion people by 2050 while at the same time maintain our emissions levels below 2^0C by the end of the century. This is more so for a continent such as Africa where much of this population is expected to arise from considering the fact that the continent is ranked to have the highest proportion of food insecure population. In order to overcome this challenge, we will need a total revolution of our agricultural production systems to systems that not only focus on increasing food production but also build our resilience to climate change. An example of one such practice is System of Rice Intensification (SRI) which is acclaimed to increase rice production while at the same time reducing the pressure on scarce water resources, minimizing agricultural greenhouse gases emissions and improving the farmers' households' adaptive capacity to climate change impacts by increasing their income. However, despite the success attributed to SRI, its uptake across Sub Saharan Africa is arguably low. This is puzzling considering the high proportion of food insecurity in the region and the region's susceptibility to damage from increased severity and frequency of climate extreme events such as droughts and floods due to its geographical positioning and the limited adaptive capacity of its people. In this work, the researcher sought to understand the barriers and enablers to the adoption of the System of Rice intensification in Mwea irrigation scheme (MIS) in Kenya. The findings show that most barriers to the uptake of SRI in MIS occur during the dissemination of SRI. Further critical barriers to the uptake of SRI in MIS were identified as follows: lack of formal SRI training, high costs of rice production, failure to involve key stakeholder institutions such as SACCOs while marketing SRI and farmer's age. Moreover, the study also depicted that most barriers to SRI adoption were intertwined, thus focusing on a single barrier would be myopic. Furthermore, enablers to the uptake of SRI in MIS are tied to the benefits of SRI pre-empted by lead farmers. This correlation implies that the benefits of SRI are key motivators for SRI adoption. Other enablers include training. However, informal training on SRI through social networks which play a crucial role at disseminating climate adaptation activities amongst small scale farmers, is marked with a lot of inconsistencies which makes it a barrier for SRI uptake. In this regard, we advise that SRI trainers clearly highlight the activities involved in SRI and their resultant benefits during initial SRI information dissemination.

DECLARATION

I declare that *Barriers And Enablers to the Uptake and Implementation of System of Rice Intensification; A Case Study of Mwea Irrigation Scheme in Kenya*, is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Mercy Njeri Gicheru July 2016

Signed:

DEDICATION

For my grandmother, Ruth Nduta Gicheru and my mother, Nancy Gacheri Gicheru.

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First, I thank the Lord Almighty without whom all this would not have been possible.

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LIST OF ABBREVIATIONS

AWD	Alternating Wetting and Drying
CGIAR	Consultative Group for International Agricultural Research
DTMs	Deposit-Taking Microfinance Institutions
EAC	East African Community
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
GHG	Green House Gases
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
IRRI	International Rice Research Institute
MIAD	Mwea Irrigation Agricultural Development Centre
MIS	Mwea Irrigation Scheme
MOA	Ministry of Agriculture
MRFCS	Mwea Rice Farmer's Cooperative Society
NCPBK	National Cereals and Produce Board of Kenya
NIB	National Irrigation Board of Kenya
OECD	Organisation for Economic Co-operation and Development
SACCO	Savings and Credit Cooperative
SSA	Sub-Saharan Africa
SRI	System of Rice Intensification
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs

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CHAPTER ONE

Introduction

Figure 1.1. Rice. Image courtesy of tribune.com.pk

1.1 Background

Rice is the staple food for over half of the world's population. More than 3.5 billion people depend on rice for at least a fifth of their daily calories (CGIAR 2013). In Africa, the demand for rice has always surpassed local production, which makes the continent highly reliant on imports. According to the Africa Rice Center (2009), rice imports by Africa represented a third of the total quantity traded on the global market despite the fact that the continent has a high potential for rice production approximated at 130 million hectares. In the last two decades, there has been an exponential increase in rice demand per capita in Sub Saharan Africa (SSA) due to rising income and shifts in consumer preferences (FAO 2011; IRRI 2013). It is further estimated that, in order to meet global rice demand of about 360 million tonnes by 2050, 100 million of which is expected to arise from Africa, rice production in Africa ought to increase by 3.92% *per annum* from 2010 to 2050 (Pandey *et al*., 2010).

In Kenya, rice is the third most important crop after wheat and maize. Most of the rice grown in the country is grown under continuous flooding by small scale farmers in large irrigation schemes established by the government for commercial and domestic use (MOA 2008; Mati & Nyamai 2009). According to the National Cereal and Produce Board of Kenya (NCPBK), rice consumption in Kenya is growing at annual rate of 12% compared to that of wheat and maize at 4% and 1%, respectively. This can be attributed to the progressive change in eating habits amongst urban dwellers (MOA 2008). As of 2015, the NCPBK placed rice production in Kenya at approximately 40,000 metric tonnes and consumption at 200,000 metric tonnes per year. This large gap between rice consumption and production makes the country also highly reliant on rice imports.

Other than production constraints, agricultural systems in Sub Saharan Africa (SSA) are highly susceptible to damage from increased severity and frequency of climate extreme events such as droughts and floods due to geographical positioning and the limited adaptive capacity[1] of the people (Di Falco *et al*.,2012). These drought and flooding events have had an impact on production of certain crops such as rice by either reducing the yields (Welch *et al*., 2010), or lowering the quality of produce (Okada *et al*., 2011). Similar damages as a result of these extreme events have also been projected in existing literature. For example, Herrero *et al*. (2010) projects reduced output in production of staple crops over East Africa due to climate variability whereas FAO bi-annual food outlook report (2015), projects a drop in rice production in Nigeria, Malawi, and Mozambique and a drop in the production of cereal grains and sugar in South Africa as a result of increased precipitation levels and droughts events, respectively.

IPCC (2007) projects that by 2020 and 2050, a population of between 75 and 250 million people and between 350 and 600 million in Africa, respectively, will be exposed to increased water stress due to climate change. This projection is not good for the majority of rice

[1] Adaptive capacity - The ability of a community to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC 2014).

producers in SSA because irrigated rice farming is the largest consumer of water in the agricultural sector (Mishra 2009; Bera 2009; Ndiiri *et al*., 2012).

With such a prognosis, it already seems preposterous to sufficiently meet global food demand of the expected 9 billion people by 2050 without revolutionizing our rice production systems through adopting policies, technologies and agricultural practices, which are aimed at increasing agricultural productivity in SSA while at the same time, building resilience[2] of the region to climate change. This is because much of the projected population increase is expected to stem from SSA and from the fact that there already exists robust evidence and high agreement that the region has the highest proportion of a food insecure population (IPCC 2014b).

System of rice intensification (SRI)[3] is a set of agro ecological practices adopted from various disciplines in order to increase rice productivity and improve water resource management. The practice was first implemented in Madagascar in 1973 and later spread to other parts of the world including Kenya (Kassam *et al*., 2011; Mati *et al.*, 2011). Despite the proven benefits attributed to SRI (Kassam *et al*., 2011; Zhao *et al.,* 2011; Siopongco *et al.,* 2013), there has been a low uptake of the practice among rice farmers across SSA (Mati *et al.,* 2011; Katambara *et al.,* 2013). Additionally, in cases where farmers have taken up SRI, partial adoption of the practice has been rampant (Ndiiri *et al*., 2013).

Therefore, this research takes a case study approach to empirically analyse adoption of SRI across Mwea Irrigation Scheme (MIS) in Kenya. The study will provide a better understanding of the factors which influence the adoption of SRI across Mwea Irrigation Scheme.

This study will use the term 'uptake and implementation' interchangeably with the word 'adoption'. In this study, the word(s) 'uptake and implementation' or 'adoption' are discrete with binary variables (a farmer is either an adopter or not). Adopters refer to farmers who were using SRI during the time of data collection.

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[2] Resilience - The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions (IPCC 2012).
[3] SRI - The System of Rice Intensification (SRI) is a set of practices, principles, and philosophies that involves manipulation of plants, soil, water and nutrient management in order to increase rice productivity (IRRI 2013).

Farmers in MIS will also be classified into three categories. First, rice farmers practicing conventional rice farming methods which involve continuous flooding of paddy through the entire season, random broadcasting of rice seedlings, and transplanting more than one seedling per hill. Second, a mix of SRI and conventional farmers who are practicing both SRI and conventional rice farming methods. Finally, farmers that have either partially or fully adopted all the practices embedded in SRI.

Additionally, various studies have highlighted different frameworks for identifying barriers and enablers (Moser & Ekstrom 2010; Burch 2010; Flottorp *et al*. 2013). This study takes a descriptive approach and uses the term 'enablers' to imply factors or conditions which ease or render it possible for farmers in MIS to adopt SRI. These factors can be either drivers, motivators or existing conditions. The term 'barriers' on the other hand is used in this research to refer to factors or conditions that deter farmers in MIS from adopting SRI.

1.2 Aim and Objectives

The primary aim of this research is to identify and analyse the enablers and barriers to the uptake and implementation of SRI by rice farmers in Mwea Irrigation Scheme. Within this, six objectives are identified:

1. To investigate SRI awareness amongst rice farmers in Mwea irrigation scheme
2. To determine the willingness of farmers to adopt SRI in MIS
3. To determine the need and the type of support required by non- SRI farmers in MIS to shift to SRI
4. To investigate rice farming challenges which are addressed by SRI in MIS
5. To investigate the effect of the distance from the research centre, Mwea Irrigation Agricultural Development Centre (MIAD), on the uptake of SRI amongst rice farmers in the scheme
6. To identify enablers and barriers to the uptake and implementation of SRI in MIS.
7. To make recommendations on supporting enablers and overcoming barriers to increase the uptake and implementation of SRI

CHAPTER TWO

Literature Review

2.1 Introduction

Over the last 100 years, constant innovation and transformation of agricultural systems have become a norm (Schultz 1964; Otsuka 2006). Crop intensification, also referred to as agriculture intensification, is said to have started in the 1950s during the green revolution in Asia. Crop intensification is achieved through the increase of labour, capital and other inputs into agricultural systems, which then results in an increase in the output per unit area of agricultural production (Tiffen *et al*., 1994; Carswell 1997). System of rice intensification (SRI) is an example of a crop intensification practice in rice cultivation. According to World Bank (2007) and FAO (2011), between 1975 and 2000, crop intensification practices increased crop yields in Asia by more than 50 percent leading to a 30 percent reduction in poverty levels. This consequently drove the spread of the practice to other regions in Asia and around the world.

2.2 The System of Rice intensification (SRI)

SRI was first introduced in Madagascar by a Jesuit priest, Father Henri de Laulanié in 1983, as a solution to increase rice yields amongst poor small scale rice farmers (Stoop *et al*. 2002; Rafaralaby 2002). SRI is a set of agro-ecologically sound practices adopted from a wide array of disciplines such as soil chemistry, ecology, sustainability and agronomy. The main practices involved in SRI (Stoop *et al*., 2002; Namara *et al*., 2003; Van Der Maden & Uphoff 2006; Nyang 'au *et al*., 2014) are:

i. Early and careful transplantation of rice seedlings between 8 and 15 days old

ii. Transplanting single rice seedling per hill

iii. Wider spacing between seedlings in well aerated and moisturized soils

iv. Alternating wetting and drying (AWD) of the paddy rice

v. Weeding (manual or mechanically)

vi. Use of organic matter to enhance growth and health of plants

Each rice seedling is transplanted solely per hill and wider spacing of the seedlings is done in a square pattern from 25 cm × 25 cm to around 50 cm × 50 cm. Spacing and planting each seedling per hill is done in order to reduce competition of resources such as sunlight, nutrients and oxygen between seedlings. Wider spacing also facilitates easy weeding through the rows created. These practices are contrary to the conventional method where seedlings are randomly broadcasted and clumped per hill in already prepared paddy fields and the spacing is narrow, usually at 15 cm × 15 cm to 20 cm × 20 cm (Namara *et al*., 2003).

Mechanical weeding is carried out in order to aerate the soils and reduce competition for resources between the plants and weeds. This is done using a push weeder. The process is made easier by wider spacing of the rice seedlings.

Alternating wetting and drying (AWD) of paddies facilitates the growth of plant roots in well oxygenated conditions. According to Gathorne-Hardy *et al*. (2013), AWD in SRI rice production helps at minimizing the amount of water resources required to produce rice which is contrary to conventional rice farming where roots grow all season under anaerobic conditions(Kassam *et al*., 2011) This practice also reduces significantly the amount of methane(CH_4) emissions in the atmosphere from rice farming. However, empirical models indicate that approximately 15–20% of the benefit gained by decreasing CH4 emission is offset by the increase in nitrous oxide emissions (Yue *et al*. 2005; Richards & Sander 2014). Nevertheless, the net global warming potential (GWP) is still significantly lower under AWD than in continuously flooded fields (Richards & Sander 2014).

Early and careful transplanting of young seedlings ensures maximum tillering of rice seedlings. This is because younger seedlings have a better potential at tillering as compared to mature seedlings(Sarathi & Haque 2011; Uphoff 2003). Transplanting of the seedlings from the nursery is done quickly to avoid subjecting the root of seedling to trauma, which might impede growth (Mati & Nyamai 2009; World Bank 2013). As a result, most farmers locate their nurseries at the edges of their paddies in order to facilitate fast transplanting of the seedlings in already prepared paddies.

Figure 1.2. A nursery located at the edge of the paddy in Mwea irrigation scheme in order to ensure quick transplant of rice seedlings.

Organic matter such as manure and compost is applied to the paddy in order to ensure long term sustainability of the soils. Organic matter is a better substitute for chemical fertilisers because it is rich in nutrients and has the ability to retain the health and richness of the soil, and microorganisms in the long run. However, it should be noted that SRI was initially implemented with chemical fertilisers which were affordable in Madagascar at the time. It was only after the Government of Madagascar withdrew fertiliser subsidies in the late 1980's that many small holder rice farmers were forced to shift to manure and compost which was easily available (Laulanie, 1993).

From Madagascar, SRI further spread to other regions around the world including Sub Saharan Africa (SSA) especially among small scale rice farmers in what Styger *et al*. (2011) referred to as a timely development for Africa to explore sustainable agricultural practices. Examples of the countries in SSA where SRI has been introduced include Benin (Jenkins

Devon 2014), Mali (Styger *et al*., 2011), Tanzania *(Katambara et al*., 2013), and Kenya (Mati *et al.,* 2011). The success of SRI has also driven non-rice farmers in SSA to extrapolate this crop intensification practice to other crops such as wheat, millet, and sugarcane (Abraham *et al*. 2014)

2.3 Introduction of SRI in Kenya

SRI was first introduced in Kenya in 2009 through a multi-stakeholder pilot project in Mwea Irrigation Scheme(MIS) whose aim was to determine the viability of SRI to increase national rice yields (Mati & Nyamai 2009). Its introduction in Kenya was opportunistic and immediately after the launch of the National Rice Strategy (2008 – 2018); a strategic document that outlined the country's rice production and development pathway for the next decade, with the aim of increasing rice productivity and overall national food security. At the same time, the National Water Resources Management Authority (WARMA) had proposed to start levying charges on all water used within the country including irrigation water as set out in The Water Act of 2002 (Mati *et al*., 2011). Mati *et al.* (2011) further argue that this would have had huge implications on small holder rice producers who required large quantities of water for irrigation but were unable to pay. Therefore, viability tests on SRI to address rice productivity and water savings issues in Kenya was received with much enthusiasm by various stakeholders across MIS.

The project commenced with three main initiatives (Mati *et al*., 2011). First, on-station research on SRI at MIAD, who were one of the collaborating partners on the project. Second, trials of SRI on the rice farms during the main growing season by volunteer farmers within the scheme. Finally, outreach awareness campaign activities such as video conferencing, field days, use of fliers, cross-learning[4] with SRI experts and workshop sessions. The on-station research and outreach campaigns started smoothly, however, on-farm trials by volunteer farmers initially stalled because it was difficult to get willing farmers during the main planting season (Mati *et al*., 2011).

[4] Cross learning – A two-way form of learning where participants learn through exchanging knowledge and sharing experiences.

Nevertheless, by the end of the main growing season in 2009, two farmers, using information broadcasted by the media, had managed to try out SRI on their own (Mati *et al*., 2011). One of the farmers initially did the try out on a 0.13 ha farm while the other practiced SRI on 0.10 ha farm. According to Mati *et al*. (2011), during this period, the two farmers faced some socio-economic constraints. For example, during the developmental stages immediately after transplanting the young seedlings, the seedlings took slightly longer to gain strength. This made the two farmers a target for ridicule by their neighbours. The two farmers were also faced with a daunting task of convincing their spouses to take up SRI during the main planting season. One of the farmers resulted in leasing out additional farm space in order to practice both SRI and conventional rice farming simultaneously as a precautionary measure.

After harvesting, the total yields from both farmers were 11 and 10 bags, respectively, which translated to a 37.5% and 100% increase in rice yields compared to that which they harvested from conventional rice farming (Mati *et al*. 2011). These results became a major breakthrough for SRI promotion and motivated other farmers in MIS to adopt SRI. Consequently, one of the farmers was employed by the National Irrigation Board (NIB) to promote SRI in the scheme alongside a field assistant, and these were tasked with the responsibility of training farmers on SRI and managing records within the scheme (Mati *et al.*, 2011).

2.4 SRI Outcomes in Kenya and the world

In 2012, a cost benefit analysis on the use of SRI in MIS conducted by Ndiiri *et al*. (2012), confirmed that, SRI did in fact increase rice yields within the scheme. SRI was performed on the well renowned aromatic basmati rice variety, locally referred to as *pishori*, which the scheme is famous for. Ndiiri *et al*. (2012) also observed that, the adoption of all SRI practices had the capacity to produce rice yields of up to 2 tonnes per hectare more than conventional rice farming, and that, the requirement by SRI to transplant one seedling per hill, which is approximately 5-7 Kg of seeds per hectare (Mati & Nyamai 2009), resulted into seedlings savings of Kshs 4,960/ha of rice paddy.

Similar studies in Tanzania by Katambara *et al*. (2013) depicted that SRI increased rice yields by producing 9.90 tonnes/ha compared to 3.83 tonnes/ha from conventional practice. Other studies in Gambia showed that SRI increased yields by 7.6 tonnes/ha (Ceesay 2011), whereas Kabir & Uphoff (2007) reported rice yields of 6.4 tonnes/ha. All these are higher compared to those obtained through conventional rice farming which averages yields of 2.1 tonnes/ha.

In addition, SRI was also found to increase efficiency of water resource utilization and promote savings on rice seedlings in MIS. For example, Nyamai *et al*. (2012) recorded total water savings of up to 1,116m^3/ha as a result of using SRI in MIS. In Tanzania, farmers reported increased water productivity from 0.14Kg/m^3 in conventional practice to 0.47Kg/m^3 using SRI. In Myanmar, Jain *et al*. (2013) recorded water savings of 36% whereas in the Sahel, farmers cited an average reduction of 27% in water use compared to conventional rice farming (Aune *et al*., 2014). These water savings translated into further savings as a result of reduced fuel consumption by machines used to pump water in irrigation schemes (Siopongco *et al*., 2013).

With regard to various rice varieties, higher yields from SRI as compared to conventional rice farming were reported in Gambia, Panama, Pakistan, Iraq, India, Sri Lanka and China. In Panama and Iraq, SRI is said to have increased rice yields by 40% and 48%, respectively through the use of local rice varieties, while in India and Gambia, SRI was used on modern rice varieties producing an increase in yields between 18 - 48% and 204%, respectively. Hybrid varieties were also reported to have increased yields from 11% in China and 220% in Pakistan (Kassam *et al.,* 2011). Savings on rice seeds were recorded in China and Sri Lanka (Namara *et al*., 2003; Zhao *et al*., 2011).

Nonetheless, SRI has also received its fair share of backlash. For example, Dobermann (2004) argues that most the intensive lowland rice areas do not fit the environmental conditions required for SRI to increase rice yields. Sheehy *et al*. (2004) also contends that SRI has no major role in improving general rice productivity after a series of experiments in China. These views were countered by Kassam *et al*. (2011) who suggested that both studies were based on disputable modelling techniques and that the studies were only hinged on three trials in China which ignored a huge number of other previous assessments such as Zhao *et al.* (2009)

In spite of the success of SRI, IFAD (2012) and Katambara *et al*. (2013) argue that there has been a low and slow uptake of SRI in MIS and in SSA. Also, Rodriguez *et al*. (2009) suggest that this is a common occurrence in the agricultural sector in SSA where efficacy of SRI to the economic, environmental and social sustainability of farming operations has been demonstrated but adoption levels remain minimal. This is worrying considering that most small scale agricultural production systems in SSA are susceptible to a range of risks including those associated with climate change such as onset of the rainy season, increased soil temperature and variability in weather patterns (Asfaw *et al*. (2014) and Mc Carthy & Brubaker (2014).

The low rate of adoption is also puzzling considering that SRI seems ideal at addressing the needs of small scale farmers in developing countries in SSA where rice productivity is low, and where most farmers are unable to produce enough rice for both commercial and domestic purposes. Aune *et al.* (2014) suggests that SRI is the ideal methodology that addresses the risks of climate change in arid low lying areas in SSA, since it requires less water compared to the conventional rice growing system, and the practice is perfectly suited as a mitigation measure since conventional rice farming is notorious for high GHG emissions.

Several researchers have investigated the factors influencing the decision of the farmer to adopt agricultural innovations in SSA and around the world (Alonge *et al*., 1995; Kassam *et al*., 2014; Wollni & Andersson 2014). Most of the studies associate the low rate of adoption of SRI and similar agricultural practices to the low adaptive capacity of the farmers. According to IPCC (2014), adaptive capacity is the ability of a community to adjust to climate change variability and extreme events, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences of climate change. The IPCC and other authors have also from time to time, highlighted a list of features that seem to determine a community's adaptive capacity and consequently their ability to adapt to the negative impacts of climate change (Smith Barry & Olga 2001). These determinants of adaptive capacity relate to the economic, social, institutional, physical and technological conditions that either facilitate or constrain the deployment and development of key climate change adaptation[5] measures.

Some of the features listed in the literature as barriers for adoption of sustainable agriculture practices include: lack of capital and credit facilities (Rodriguez *et al*., 2009; Mati *et al.,* 2011), high labour requirements (Namara *et al*., 2003; Moser & Barrett 2006), delayed benefits from the practice (Stevenson *et al*., 2014; Corbeels *et al*., 2014), and complete change of practices from previous system (Ekboir 2002). Conversely, enablers cited by researchers in similar studies include integrating new knowledge with traditional knowledge (Ospina & Heeks 2012), and the motivation and support received from neighbouring farmers (Noltze *et al*., 2012).

According to Rodriguez *et al*. (2009), these research focused mainly on change agents [6]perspectives, who in most cases arrived at the conclusion that farmers are reluctant to change. He argues that this conclusion is myopic and masks the very barriers that the research endeavours to elicit in the survey by failing to focus on the deeper and complex issues that make the farmers reluctant to change. Shackleton *et al*. (2015) also contends that much of this research is focused on the barriers and argues that although awareness of barriers is essential, research on enablers to adoption of agricultural innovations is equally essential and hence, the need to give equal attention to both enablers and barriers.

For these reasons, this study will seek to identify the key enablers and barriers to the uptake and implementation of SRI by rice farmers in Mwea Irrigation Scheme. Evidence from existing literature suggests that the distance of rice farmers from the research centre, MIAD, where SRI was first pioneered in Kenya, is a key barrier to the uptake of SRI in Mwea Irrigation Scheme (MIS). This is because there are few research and extension workers tasked with promoting SRI within MIS (Ndiiri *et al*., 2013; Mati *et al*., 2011). In addition, these few extension workers also double up as employees of the government with different project mandates other than SRI. Consequently, the researcher hypothesizes that the spread of SRI and its adoption within the scheme will most likely be like a ripple effect

[5] Adaptation - Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC 2012).
[6] Change agent - One who intervenes by bringing about change in form of new knowledge or skill set that would be useful in performing a certain role in order to help improve the lives of a community or system.

where farmers who live further away from the research centre are less likely to take up SRI during the initial years after its inception compared to those nearer the research centre.

CHAPTER THREE

Research Methods

3.1 Introduction

The research methodology presented in this study is both qualitative and quantitative. Qualitative because the study aims to understand the underlying reason for an existing situation, to provide insight into the settings and circumstances of existing problems and finally, generate possible solutions and recommendations that, *a priori*, had not factored in. The quantitative aspect of this study is used as a complement for the qualitative research by seeking measurable data with regards to the general existing situation. A case study approach was used for this study in order to obtain specific information about SRI uptake in the study area. This is because SRI is said to produce different results globally depending on the soil and climatic conditions of the area.

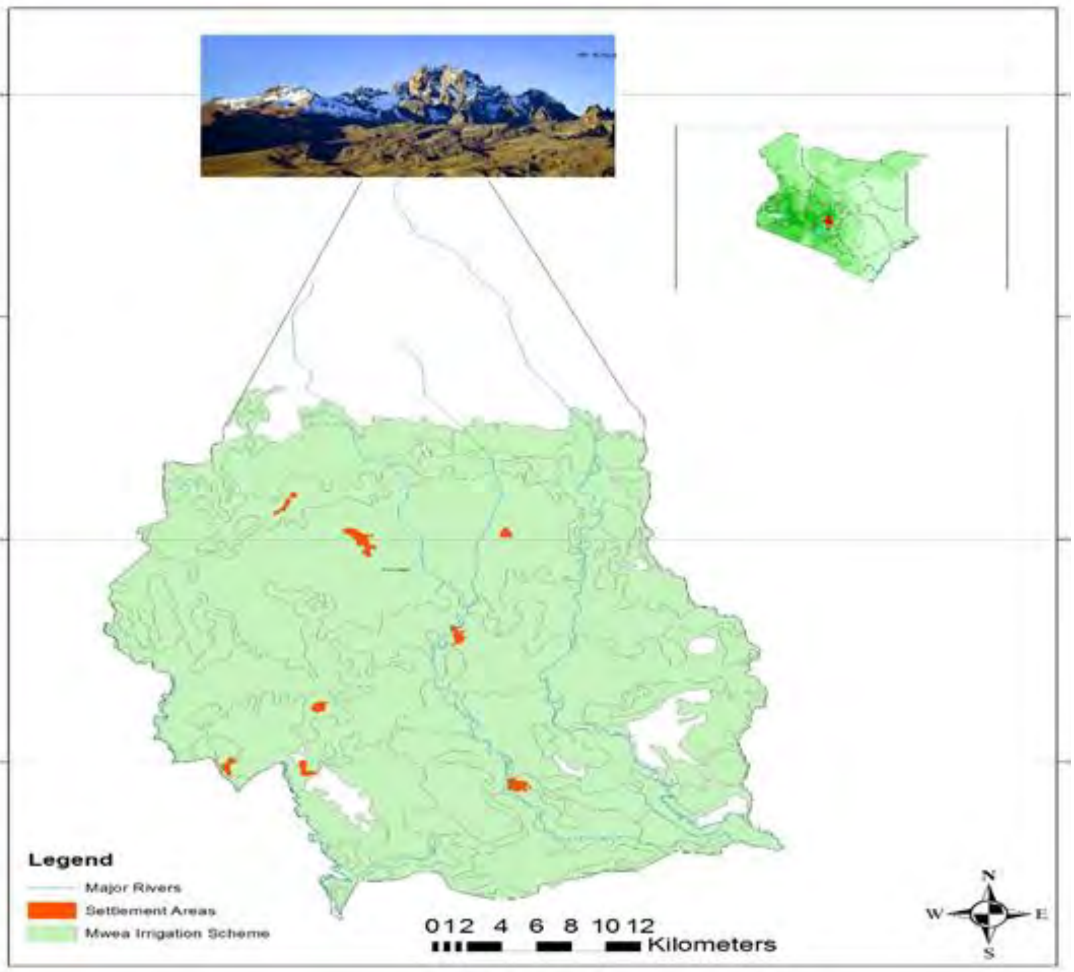

Figure 3.1. Map indicating location of Mwea Irrigation Scheme within Kirinyaga County in Kenya.

3.2 Description of the Study Area

The study was undertaken in Mwea Irrigation Scheme (MIS). MIS was started in 2009 and is the largest rice irrigation scheme in Kenya. MIS is situated in Kirinyaga County of Kenya (see Figure 3.1 Above). The scheme lies within latitude 37°13 E and 37°30 E and longitude 0°32 S and 0°46 S on the south eastern slopes of Mount Kenya and 100 Km from Nairobi. It is the largest of the four rice irrigation schemes in Kenya accounting for 78 percent of irrigated area, 88 percent of rice produced in the country, and 98 percent of the gross value of output from the four schemes between 2005 and 2010 (FAO, 2012).

The scheme covers an approximate total area of 12,000 Ha of which 6,500 Ha are paddy rice fields while the remainder comprise of service amenities and subsistence horticultural farming (Mati *et al*., 2011). The scheme is characterised by black cotton soil and is classified as tropical with a semi-arid climate. It receives an annual precipitation of 950 mm and has a bimodal rainfall season distribution: April and May (long rains) and October and November (short rains), with an annual mean temperature between 23-25°C (Mati *et al.,* 2011). Water is distributed within the scheme through a conveyor belt system linked to the main canal between two rivers, namely Nyamindi and Thiba.

The scheme was developed for large scale rice farming by the British in the 1950s during the colonial era. It was also used as a detainment camp for the rebels of the colonial administration (Mati *et al.,* 2011; Nyamai *et al.,* 2012). After independence, the government took over the scheme and settled landless peasant farmers to live alongside the ex-detainees. Plot-holders did not, and still do not, own their land but are considered as tenants with renewable annual leases who could lose their rights if they do not manage their plots as per required guidelines by the scheme administrators (FAO, 2012). However, their leases are heritable.

The National irrigation Board (NIB) was responsible for overseeing tasks such as land preparation, credit provision, harvesting and marketing on behalf of the farmers (Kabutha &

Mutero 2002). In 1998, farmers expressed their discontentment with the management of NIB and pushed for reforms to have their own cooperative society, that is, the Mwea Rice Farmer's Cooperative Society (MRFCS) responsible for managing the scheme. The cooperative society took over the management of the scheme in 1998. However, this was short lived as the MRFCS was faced with a series of administration challenges. Hence, in 2003, both farmers and government came up with an agreed upon working formula to have both the NIB and the farmer's co-jointly manage the scheme (Kabutha & Mutero 2002).

The scheme supports a population of over 50,000 and is divided into five areas, namely Mwea covering approximately 1,300 Ha, Tebere 1,400 Ha, Thiba 1,200 Ha, Karaba 1,100 Ha and Wamumu 1,200 Ha (Njeru 2012). In addition, the scheme has an approximate 1,620 hectares of out grower sections under paddy (NIB 2015). This out grower section is commonly referred to as "*Jua kali"*, a Swahili name which translates to '*fierce sun*' in English, and implies the non-formal sector of an economy. The scheme largely comprises small scale farmers. This is thought to be a consequence of increased subdivision and sale of land parcels to younger generations and new immigrants which have, in turn, resulted in increased stress on available resources such as water (Esipisu 2013). In this regard, plans are currently underway to expand the scheme by incorporating the two out-grower sections; Nderwa and Curukia (MIAD officer) and to build a dam on river Thiba which will cater for this expansion (Mati *et al.,* 2011).

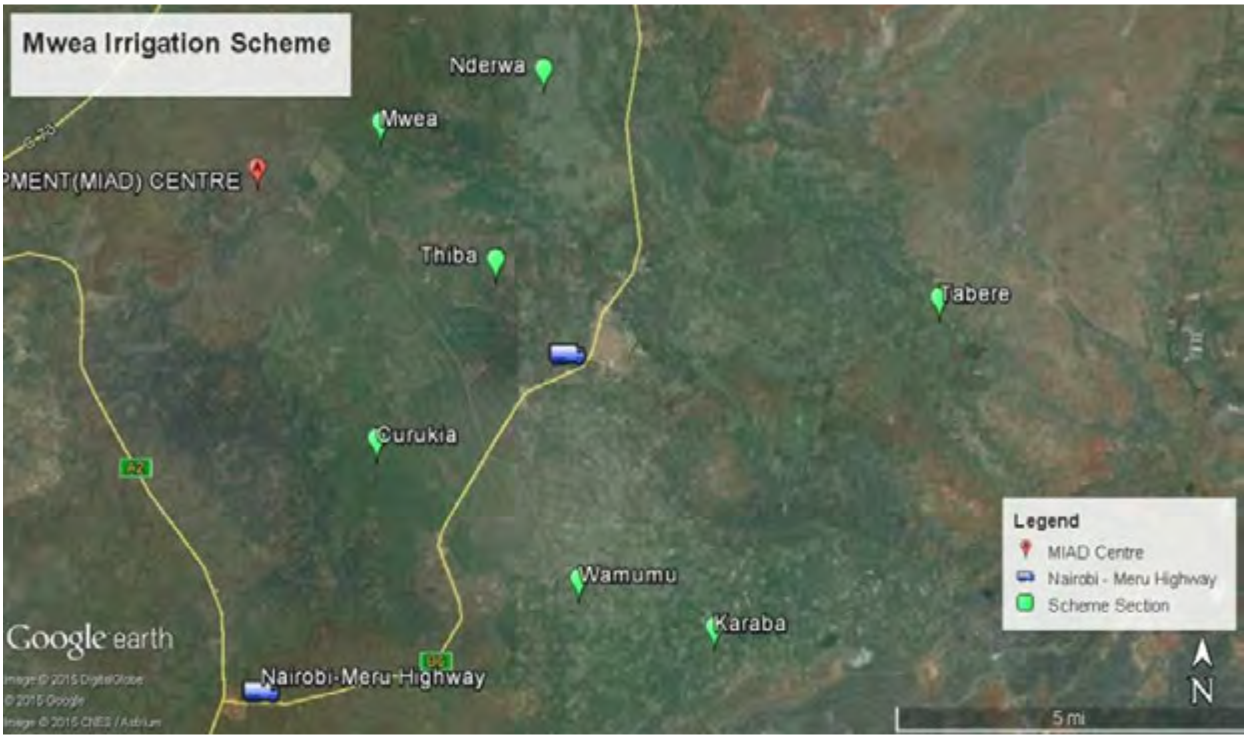

Figure 3.2. Map showing location of the seven sections in the Mwea Irrigation Scheme (green markers)

3.3 Target Population

The target population for this research were rice farmers, SRI research officers and extension farmers from Mwea Irrigation Agricultural Development Center (MIAD) working on SRI within the scheme. The study targeted 5 extension officers and 59 rice farmers in the seven sections of the scheme, five within the scheme and two out-grower sections, namely Mwea, Thiba, Karaba, Wamumu, Tabere, and Curukia and Nderwa, respectively as shown in Figure 3.2. The target was to interview a minimum of 7 farmer respondents in each of the section.

3.4 Data collection

The Data collection process was done in stages as illustrated in Figure 3.3.

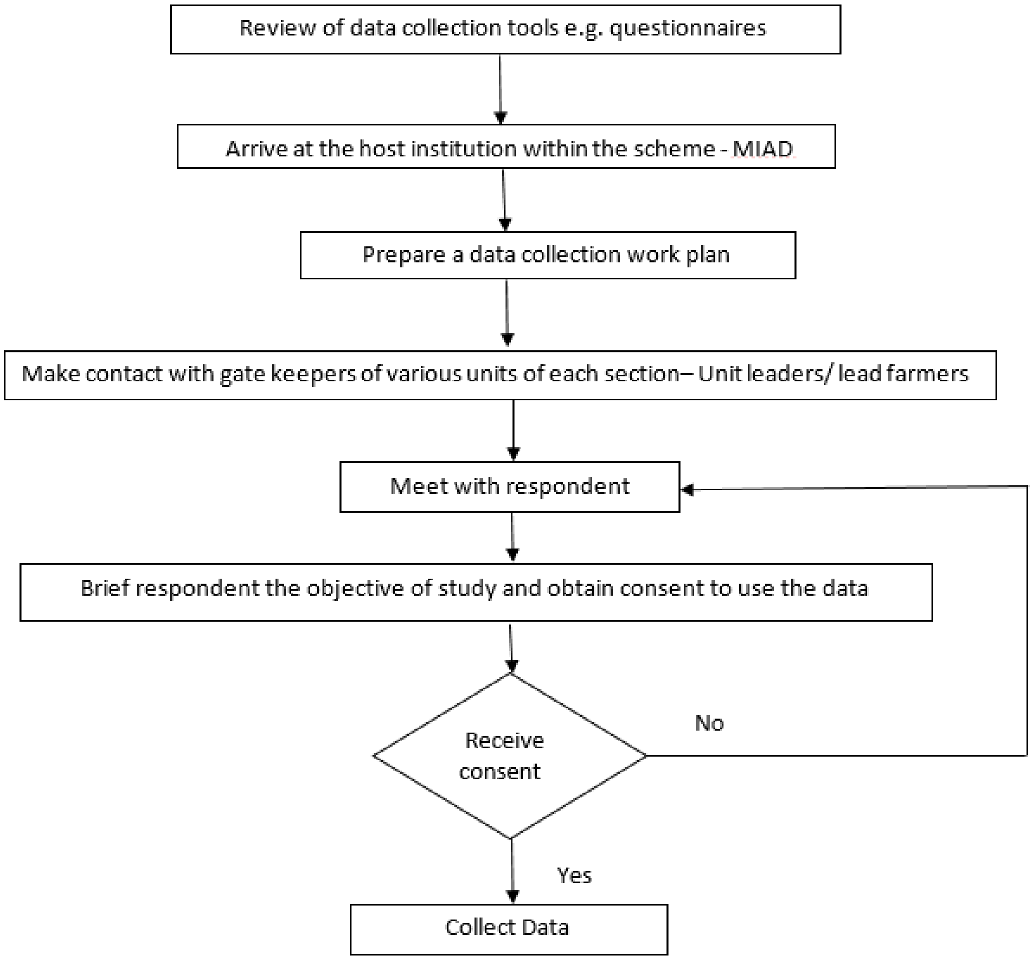

Figure 3.3. Flow chart of the data collection process at the Mwea Irrigation Scheme, Kenya.

3.4.1 Data Collection Tools

Household Survey Questionnaire: this was the main tool for primary data collection. The questionnaire had both open- and closed-ended questions, which had been customised to cater for the needs of the farmers using either SRI, conventional or a mix of the two rice farming practices. Respondents to the household survey questionnaires were sourced from their homes as well as their farms. Prior to filling in the questionnaire and answering interview questions, all the respondents were briefed on the objectives of the project and their consent was secured either in written form or verbally for those who were illiterate or those not able to write because of old age.

Key Informant Interviews: this tool was used during discussions with a MIAD research officer, farm unit leaders and an extension farmer. The responses of the Key informant interviewees were used to complement data obtained through the household survey questionnaires. For example the key informant interviewees provided us with general administration information on the scheme that farmers did not know about. They also helped with elaborating and clarifying some of the information provided by the farmers in their native language.

Observation and photography: used to complement the other two data acquisition tools. Photos of the farm, various farm activities and technical structures such as water drainage systems between rice paddies were used to conceptualize the activities done during SRI as elaborated by rice farmers during data collection.

3.5 Survey Instrument Objectives

Each questionnaire used for the household survey had 17 questions divided into four sections, namely general information, rice farming practices and SRI awareness, willingness to take up SRI and challenges facing rice production in MIS, and Barriers and Enablers to uptake of SRI.

i. The general information section

This was the first section of the questionnaire. It was made up of eight questions. The questions were aimed at providing a brief overview of the each respondent's personal details such as age, gender, contact, geographical location of the farm, acreage, source of income, level of education and profession.

ii. Rice farming practice and SRI awareness

This is the second part of the questionnaire which comprised the next four questions (9-12). The aim of these questions was to determine whether the respondent had knowledge of SRI and the depth of their understanding on SRI. Furthermore, this section sought to establish each farmer's current rice farming practice and the reasons behind their choice of rice farming practice.

iii. Willingness to take up SRI and Challenges facing rice production in MIS.

The third section of the questionnaire (13-16), looked into the willingness of non-SRI farmers to shift to SRI. This also sought to find out from the farmers the main challenges facing rice farming as well as their thoughts or suggestions on possible solutions to these issues. Furthermore, this section enquired from farmers whether or not SRI had in fact provided any solutions to some of the challenges cited. Finally, the third section investigated if there was a need for support and the type of support required by farmers to shift to SRI.

iv. Barriers and Enablers to the uptake of SRI in MIS

The fourth and final section of the questionnaire (17) sought to enquire from the respondents the barriers and enablers to SRI uptake within MIS. This section comprised of three questions, the first two questions required farmers to respond to a list of multiple enablers and barriers and tick those that resonated with their views in regards to uptake of SRI in Mwea Irrigation scheme. This list of potential barriers and enablers was informed by existing literature on barriers and enablers to the adoption of various sustainable agriculture practices across SSA as covered in chapter 2 of this paper. Creating the sample list of potential barriers and enablers to the uptake of SRI across MIS prior to data collection was necessary in order to jog the respondent's memory as well as to minimise duplication and information overload. However, to counter the possible risk of excluding vital barriers and enablers that played a significant role in SRI adoption across MIS from our research, we created the third and final question of this section which provided an option for farmers to indicate any other barriers and enablers that were not covered in the sample list but determined the uptake of SRI across the scheme.

3.6 Study Design

Both qualitative and quantitative data were collected. Cross-sectional design was used to guide data sourcing, processing, analysis and interpretation. At the household level, the quantitative approach was used to elicit quantifiable and numerical data from the target audience whereas the qualitative approach was used to source for characteristic information such as each farmer's description of what SRI entails.

Respondents to the household surveys were arrived at using purposive snowball sampling whereas expert sampling was used to determine key informant interviewees for the study. Snowball sampling was extremely useful for effective time management in areas such as Curukia and Nderwa where households were sparsely distributed compared to the rest of the sections. Purposive sampling was also used to target a higher number of respondents from Tabere section which was determined to be the largest and the furthest from the research centre, MIAD, where SRI was first introduced. This was done in order to provide an in depth understanding of whether distance was a key barrier to the uptake of SRI in MIS. Expert sampling was used to identify Key informant interviewees, who were people with a great deal of knowledge about SRI in MIS. These include: research officers, unit leaders and extension farmers tasked with the responsibility of training and creating awareness of SRI within the scheme.

The respondents sample was 64 comprising of 5 key informant interviewees and 59 household interviewees who were distributed across MIS as shown in Table 3.1 below.

Table 3.1. Household questionnaire interviewees' distribution across sections in the Mwea Irrigation Scheme.

Section	**No. of Respondents**
1. Curukia (Outgrower)	8
2. Karaba	8
3. Mwea	8
4. Nderwa (Outgrower)	7
5. Tabere	12
6. Thiba	8
7. Wamumu	8
TOTAL	**59**

3.7 Data Processing and Analysis

Data cleaning was done through manual inspection in order to verify, omit inapt and duplicated data. The cleaning and analysis was made easier by the use of question skip logic during data collection, which meant that respondents were directed to the next relevant question based on their answers to the previous question.

Quantitative data was collated and analysed using Microsoft Excel. Qualitative data was first translated, transcribed and analysed using the grounded theory approach (Heath & Cowley 2004). Codes were created to represent different characteristics of the data. These codes were used as headings in Microsoft Excel where qualitative data was categorised accordingly. Thereafter, the spreadsheets were exported into Statistical Package for the Social Sciences (SPSS v 22.0) for analysis.

Descriptive analysis and inferential statistical treatments were performed on the data to identify frequency distribution patterns and trends within the data. The output of the analysis was thereafter presented in illustrative tables. The output from Microsoft Excel was presented in frequency distribution graphs and charts.

3.8 Characteristics of the Respondents

Out of the 59 household questionnaire respondents, 44 were male and 15 were female. 24 out of the total 59 respondents practiced SRI, 26 practiced conventional and the remaining 9 combined the two practices as shown in Figure 3.4.

This combination of both practices implied that the 9 farmers either divided their farms to practise both methods in the same season, or they alternated between the two methods from season to season.

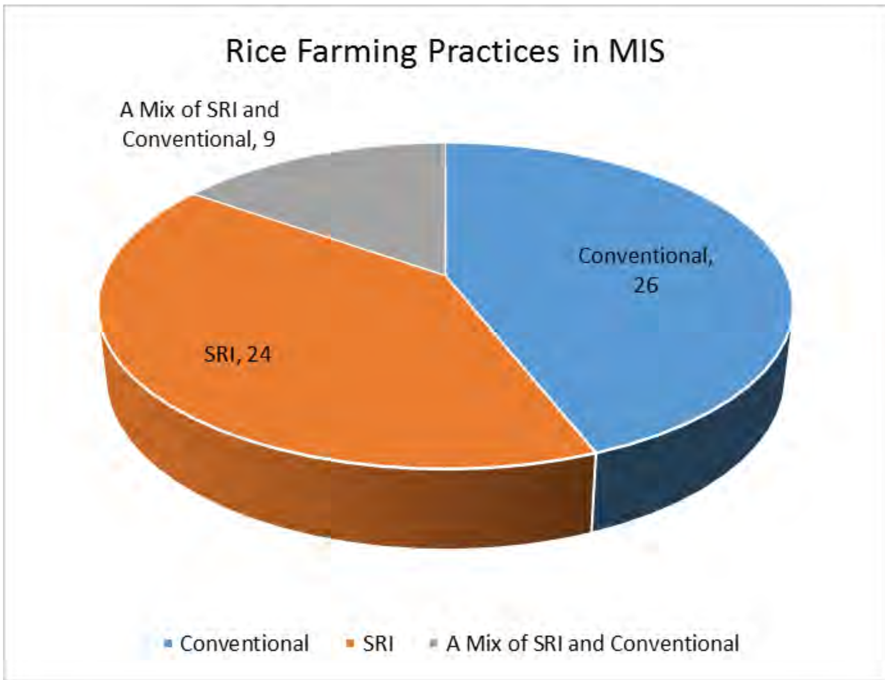

Figure 3.4. Rice farming practices across Mwea Irrigation Scheme in Kenya.

50 out of the 59 farmers were full time farmers who relied on rice farming for their daily source of food and income. Of the 59 farmers, 23 had attained primary level education, 26 had acquired secondary education and the remainder had reached tertiary level education. The age of the sampled respondents was distributed as listed in Table 3.2.

Table 3.2: The age distribution of the respondents in the Mwea Irrigation Scheme, Kenya

Age cohorts (years)	No. of respondents
20-39	17
40-59	24
60-79	15
Over 80	3

3.9 Limitations

The data was collected during the last stretch of the pre-planting season. During this time, majority of the farmers were busy ploughing and levelling their lands but a few farmers had already started transplanting their seedlings. Consequently, it was initially challenging for the researcher to get willing respondents across all sections of the scheme. Additionally, the sparse household distribution density in the outgrower sections, namely Curukia and Nderwa, as well as the fact that not all farmers in these sections were rice farmers, meant that the researcher had to walk for long distances to locate willing rice farmers. Finally, the study only managed to get 15 willing female respondents to the household questionnaires who make up 25% of our total sample size.

CHAPTER FOUR

Results

4.1 Introduction

The results of the 59 household questionnaire surveys and 5 key informant interviews are presented in this section. The study explored the awareness of System of Rice Intensification (SRI) in the Mwea Irrigation Scheme (MIS). Thereafter, it highlights the willingness of non-SRI farmers to shift to SRI, and the prerequisite for these farmers to shift to SRI. Subsequently, the farmer's views on barriers and enablers to the uptake of SRI within MIS are presented. Finally, this chapter wraps up by describing the rice farming challenges in MIS and possible solutions to these challenges as put forward by the farmers.

4.2 Awareness

Awareness of SRI amongst rice farmers in MIS was determined by enquiring how many farmers had knowledge of SRI. The study further probed into each farmer's understanding of SRI by requesting that the farmer provides a comprehensive list of practices that are entailed in SRI. Thereafter, the responses provided by the farmers were cross-checked against a guide (Mati & Nyamai 2009) for promoting SRI in MIS. The output was as follows:

A total of 56 out of the 59 respondents (95%) claimed to have knowledge of SRI. This revealed that most of the rice farmers in MIS are aware of SRI. However, out of the 56 farmers who claimed to know what SRI was, only 1 provided a full description of all the practices that make up SRI as previously highlighted (Mati & Nyamai 2009), and is shown in Table 4.1.

Table 4.1. The number of farmers that highlighted each practice in SRI according to the guide by Mati & Nyamai (2009) to SRI promotion in the Mwea irrigation scheme, Kenya.

Key practices (Mati & Nyamai, 2009)	**No. of respondents**	**% of Response**
1. Transplant one per hill and in a square pattern	17	30
2. Alternate wetting and drying of the farm (AWD)	17	30
3. Transplant young seedlings between 8 and 15 days old	13	23

4.	Wider spacing preferably 25 cm by 25 cm	11	20
5.	Quick and shallow transplant to avoid subjecting roots to trauma	1	2
6.	Weed control – manual/mechanised	1	2
7.	Enhance soil organic matter	1	2

A total of 17 out of 56 farmers (30%) quoted transplanting each rice seedling per hill and alternating wetting and drying. 13 farmers (23%) mentioned transplanting young seedlings between 8 and 15 days, whereas 11 farmers (20%) mentioned wider spacing of seedlings. The least mentioned practices by the farmers were quick and shallow transplant of seedlings, weed control and enhancing soil organic matter. Each of the latter three practices got a single mention each.

Other than the seven practices listed in Table 4.1, 47 out of 56 farmers (84%) of the farmers in our sample cited planting rice in a line while 27 out of 56 (48%) farmers cited transplanting rice seedlings between 15 and 21 days as other practices embedded in SRI.

Farmers were also required to provide their source of SRI information. 28 out of 56 farmers claimed their initial source of SRI information to informal sessions with other farmers within the scheme, while 25 out of 56 farmers claimed to have received SRI information from the Mwea Irrigation Agricultural Development Centre (MIAD) researchers and farm extension workers. The other 3 farmers credited their source of SRI information to an organisation by the name, RICEMAPP. This is presented in Figure 4.1.

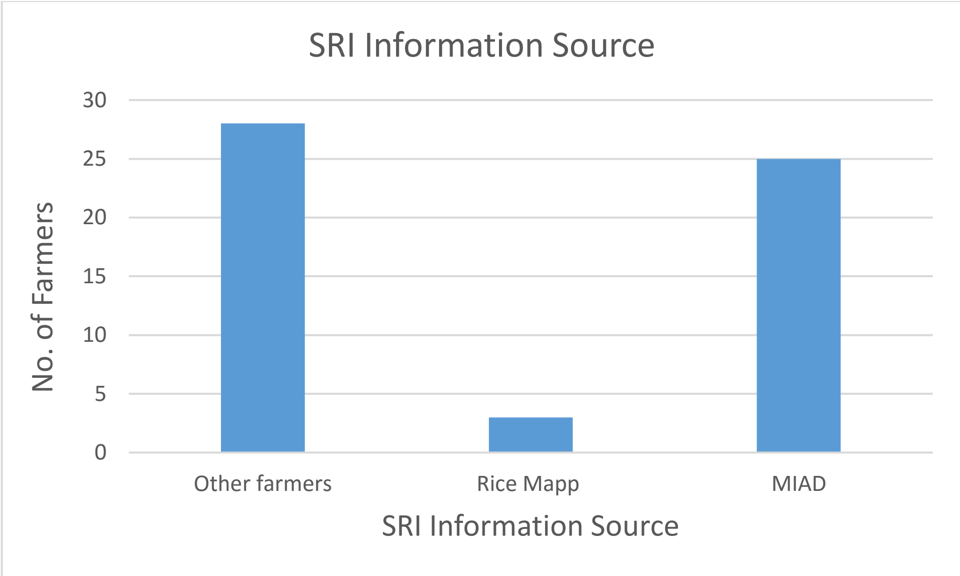

Figure 4.1. Graph Indicating sources of SRI information

4.3 Willingness to Take Up SRI

Our results suggest that more farmers in the Mwea Irrigation Scheme are willing to take up SRI. This can be inferred from the increasing number of farmers taking up SRI over the years as well as the confirmed number of non-SRI farmers who stated that they would be willing to take up SRI. Table 4.2 shows the number of non-SRI farmers who took up SRI each year and the cumulative number of SRI farmers in MIS from the inception in 2009 to the time of data collection.

Table 4.2. The number of SRI farmers that took up SRI each year and the cumulative number of SRI farmers from the sample who took up SRI since inception in 2009.

Year	2009	2010	2011	2012	2013	2014	2015
No. of SRI Uptake Each Year	0	2	3	2	7	6	4
Cumulative No. of SRI Farmers Each Year	0	2	5	7	14	20	24

Based on the cumulative figures in Table 4.2, there has been an increase of SRI uptake since its inception in 2009. Out of the 24 SRI farmers in our sample population, none of the respondents took up SRI in 2009. However, 2 farmers picked up SRI in 2010. Thereafter, 3 other farmers picked up SRI in 2011, followed by another 2, 7, 6 and 4 farmers in 2012, 2013, 2014 and 2015, respectively.

Moreover, 16 out of the total 26 conventional rice farmers indicated that they were interested in taking up SRI. According to non-SRI farmers, the enthusiasm to shift to SRI is mainly driven by their desire to gain benefits of SRI which had been gained by other farmers, who had successfully increased their rice yields and minimised their water consumption by using SRI. The distribution of rice farming practices across MIS are shown in Figure 4.2.

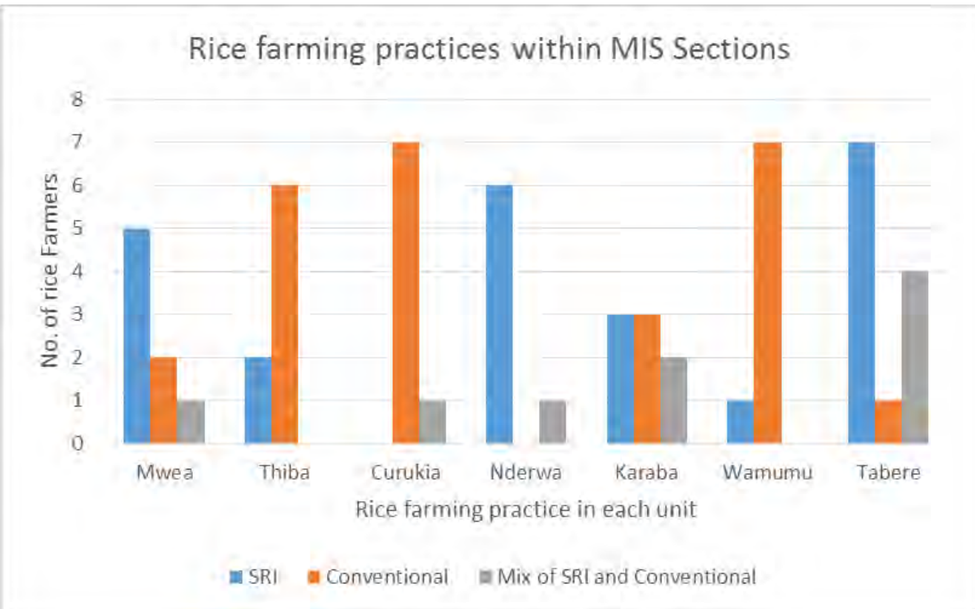

Figure 4.2. Graph Showing rice farming practices across the Mwea irrigation scheme, Kenya.

4.4 Type of Support Required to Shift to SRI

A total of 15 out of the 16 conventional rice farmers willing to take up SRI claimed that they were willing to shift to SRI on the condition of support. The study merged the responses on the type of support required to totally shift to SRI from these 15 farmers with the 9 farmers practicing a mix of SRI and conventional methods as shown in Table 4.3.

Table 4.3. Type of support required by rice farmers to shift to SRI

Type of Support	**Response**	
	N = 24	**% of Total Response**
Training	18	72
Push Weeder	9	36
Fertilisers	6	24
Levelling the Farm	5	20
More land to produce	4	16
Seeds	2	8
Water Gauge	1	4

The need for training on SRI in order to shift to SRI was highlighted by 72% of the farmers. Another 36% of the farmers cited the need for push weeders as a means of support to shift to SRI whereas 24% of the farmers cited fertilisers. The rest, 20%,16%,8% and 4%, cited the need for infrastructure support to level their farms, more land to produce rice, and availability of seeds and water gauges to regulate the amount of water during alternating wetting and drying (AWD) of the farms, respectively.

4.5 Barriers to the Uptake of SRI in the Mwea Irrigation Scheme.

In order to determine the barriers hindering the uptake of SRI by rice farmers in MIS, all farmers were asked to give their view on what barriers they thought were hindering the uptake of SRI in MIS. 43 out of 59 farmers responded as shown in Table 4.4. 13 out of the remaining 16 farmers cited lack of knowledge of possible barriers, whereas 3 farmers cited the lack of knowledge on SRI.

Table 4.4: Barriers to the uptake of SRI

	N= 43 respondents	**% of total Respondents**
Barriers to Uptake of SRI		
Lack of formal training	32	74
Lack of detailed knowledge on SRI	19	44
Varying information on the practice	15	35
Lack of endorsement by reliable institutions such as SACCOs	9	21
Initial high cost of implementation	8	19
Age	8	19
Land ownership constraints	7	16
Mix of agendas during SRI promotion	6	14
Lack of proper infrastructure	6	14
Time consuming	4	9
The practice is still very new	3	8
Reluctant to change	2	7
Lack of expansive markets	1	2
Farmers' perception that they were not involved in SRI dissemination	1	2
Distance from MIAD research centre	1	2

A total of 32 out of 43 farmers claimed that the lack of formal training was the main reason why SRI was not taken up within the scheme. Most SRI farmers who had received formal training claimed to have received an average of one formal training session from agricultural extension officers. These sessions were said to have lasted between 2 to 3 days. Also, 19 out of the 43 farmers indicated that the lack of detailed knowledge on SRI within the scheme barred the uptake of SRI while 15 out of the 43 farmers were of the opinion that the inconsistencies in information on SRI prevented more farmers from taking up SRI. 10 out of the 43 farmers cited the lack of continuous support with feedback channels by SRI research officers and extension farmers.

Other farmers expressed their concerns over the failure by SRI promoters to incorporate reliable institutions such as the existing Savings and Credit Cooperatives societies (SACCOs) during SRI awareness campaigns. Another concern raised by the farmers was the manner in which the government delivered SRI awareness to farmers within the scheme. According to some farmers, the SRI promotion process was entangled with other agendas such as marketing fertiliser brands. Hence, this act not only overshadowed the promotion of SRI but also portrayed the process as a marketing tactic by the government. Other barriers include the high initial costs of shifting to SRI, which were attributed to the cost of purchasing or hiring machinery to level the land during the initial shift to SRI; high labour cost; and the cost of push weeders.

Interestingly, the farmers also pointed out age as a significant barrier to the uptake of SRI. According to some farmers, SRI involved a lot of monitoring which was tedious and time consuming, especially for elderly farmers. Another concern was the capacity to own land. Farmers aged between 20-39 years argued that majority in this age cohort were just starting out in rice farming and therefore they had smaller farm parcels compared to the rest of the age groups. Consequently, the spacing of rice seedlings in their small parcels as required by SRI was considered wastage of the already limited farm space. In this regard, most old people within the scheme opted for conventional rice farming over SRI. This concern was validated by our analysis of the respondent's age in relation to current rice farming practice and the relationship between the average acreage per farmer and age as shown in Figures 4.3 and 4.4, respectively.

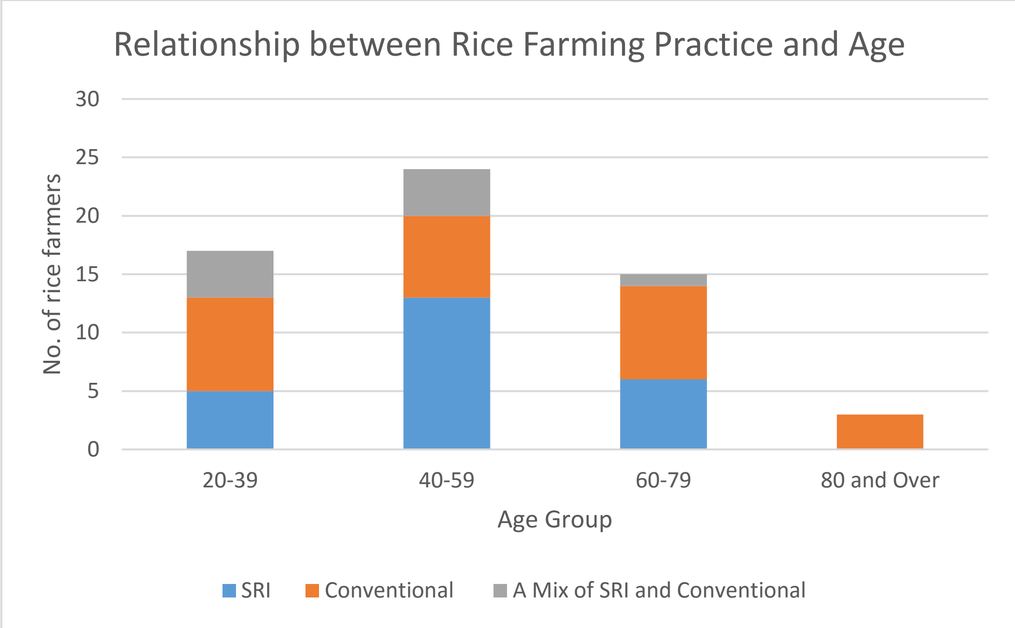

Figure 4.3. The Relationship between rice farming practice and age

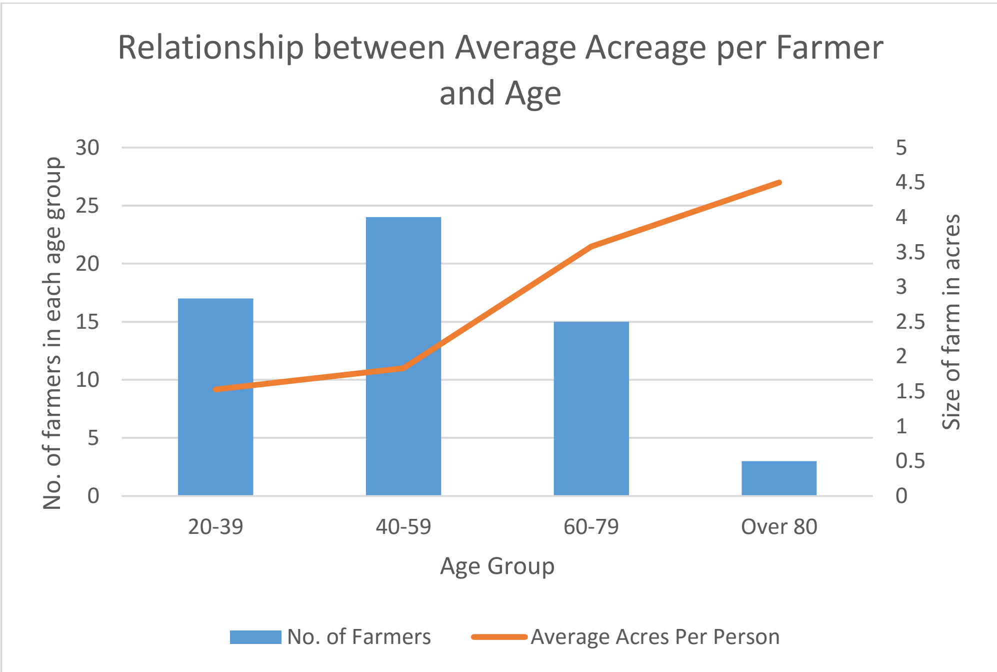

Figure 4.4. The Relationship between average acreage per farmer and age

Figure 4.3 indicates that all respondents in the age group 80 and over practiced conventional rice farming whereas in the age group 20 to 39 there was an almost similar proportion of farmers practicing the three rice farming practices and in the age groups 40 to 59 and 60 to 79, there were more farmers practicing SRI and conventional rice farming compared to a combination of the two practices. Figure 4.4 on the other hand indicates the size of the land per farmer. This is what each farmer currently possesses as either owned or leased land. The graph shows an increase in the average acreage with an increase in age. Farmers aged 20 to 39 years had an average of 1.5 acres per person whereas farmers in the highest age group, over 80 year, had an average of 4.5 acres per person.

Land ownership was also listed as a barrier. Farmers who had leased farms found that levelling a leased farm for just a season in order to practice SRI was a costly venture. More so if the lease was not subject to renewal in the near future. In addition, young people (age group 20-39 claimed that they had limited land to invest in SRI. Other barriers cited include poor irrigation infrastructure such as blocked corrugated channels, poor road networks, "newness" of the practice, farmers reluctance to change, farmers' perception that they were not fully involved in SRI inauguration and dissemination process within MIS, limited markets to expand rice production due to proliferation of imports, and the distance from the MIAD research centre.

From the list of barriers provided by the farmers as shown in Table 4.4, all of the barriers were further divided into three categories (Table 4.5), namely delivery of SRI, farmer's perception and capacities, and external factors. In the first category, Delivery of SRI, we collated all barriers that occur during SRI information diffusion. The second category highlights the barriers that were tied to farmers' perceptions of the practice and individual capacities, whereas the third category, External Factors, indicates the barriers that are as a result of factors beyond the farmers' and extension services capacities.

Table 4.5. Categories of barriers to the uptake of SRI in the Mwea irrigation scheme, Kenya.

Barrier Category	N=43 Respondents	Total Responses
a. SRI Information dissemination and delivery		
Lak of formal training on SRI	32	
Lack of detailed knowledge on SRI	19	
Varying information on SRI	15	
		66
b. External Factors		
Initial high cost of implementation	8	
Land ownership constraints	7	
Lack of proper infrastructure	6	
Time consuming	4	
'Newness' of the practice	3	
Farmers' perception that they were not involved in SRI	1	
dissemination	1	
Lack of expansive markets	1	
Distance from MIAD research centre		31
c. SRI marketing strategies		
Lack of endorsement by reliable institutions such as SACCO	9	
Mix of agendas during SRI promotion	6	
		15
d. **Farmers Individual Characteristics**		
Age	8	
		8

Figure 4.5 indicates that most barriers to the uptake of SRI in MIS occurred during SRI information delivery process, followed by external factors, SRI marketing strategies and individual farmer characteristics.

4.6 Enablers to Uptake of SRI within MIS

Enablers to the uptake of SRI in MIS are tied to the ability of farmers to reap benefits from the practice. This is evident from Table 4.7 which shows that the main perceived benefits of SRI, increase in rice yields and income, had coincidentally been acclaimed by majority of the farmers (89% and 85% respectively) to be the main enablers to the uptake of SRI.

Table 4.6. Enablers to the uptake of SRI within MIS

	N= 27 No. of respondents	% of total respondents
Enablers to the Uptake of SRI		
The practice increases rice yields	24	89
The practice produces higher income from the heavy grain	23	85
Training provided by MIAD	20	74
SRI is a suitable water conservation method	17	63
Savings on seed use	8	29
Availability of proper irrigation infrastructure	4	14
Favourable Government support of SRI	1	4
Proximity to Research centre - MIAD	1	4
Moral & technical support from neighbouring farmers	1	4

Table 4.7: The benefits of SRI perceived by farmers

Perceived Benefits of SRI	N= 33 No. of respondents	% of total respondents
Heavier grain hence more income	25	76
High rice yields	22	67
Savings on seeds	15	45
Minimal water requirements	15	45
Better quality grain	7	21
High tillering rice crop	3	9
Rice grain does not break during milling	2	6
Ease of Labour demonstration	2	6

Other SRI benefits cited as enablers include increased income from the heavy grain, water conservation and savings on seedlings at 85%, 62% and 29%, respectively. 85% of farmers were of the opinion that SRI uptake was fuelled by the desire for a higher income. The higher income was as a result of the heavier rice grains produced through SRI in a market system where rice is sold per kg rather than per bag. In addition, 74% of farmers claimed that the training provided by MIAD had also played a role in increasing the uptake of SRI. This clearly depicts the value of formal training during promotion of a new agricultural practice. Further enablers mentioned by farmers include availability of proper irrigation infrastructure, proximity to MIAD and technical support from their neighbouring farmers.

4.7 Challenges Facing Rice Farming and Potential Solutions for the Challenges

The challenges faced by the farmers we sampled in the MIS are summarized in Table 4.8.

Table 4.8. Challenges facing Rice farmers in Mwea Irrigation Scheme, Kenya.

Challenges Facing Rice Production	Responses N=57	% of Responses
Finance	37	65
Market	30	53
Water shortages	24	42
Lack of proper infrastructure (Road, irrigation channels)	17	30
Pests and Diseases	9	16
Timely resource availability	6	11
Transplanting young seedlings	3	5
Land ownership constraints	1	2
Weather	1	2

A total of 37 out of 57 farmers claimed finance to be the main challenge facing rice farmers within MIS. Another challenge cited was marketing with30 out of 57 farmers expressing their concerns over constant fluctuations in the price of rice as a result of import dumping. Other challenges mentioned by farmers include, land ownership constraints, lack of proper irrigation infrastructure, poor road networks, pest and disease invasion, unavailability of resources such as seeds, research and labour as well as water shortages. Finally, weather was also cited as a challenge by one farmer who claimed that the cold season affected the yield.

Farmers were also asked to provide us with a list of suitable solutions to tackle the challenges encountered. Their responses are summarized in Table 4.9.

Table 4.9: Proposed Solutions by the farmers for challenges in rice production

Solutions for challenges in rice production	**N = 57 responses**	**% of total respondents**
Government regulation on imports to promote local rice production	18	32
Government to attract microfinance investors in the area	14	25
Research on pests, diseases and drought tolerance seed varieties	9	16
Improve road networks within the scheme	9	16
Government to build a water reservoir	8	14
Improve irrigation infrastructure	4	7
Government to subsidize on fertilizer costs	3	5
Timely supply of required fertilizers by the government	3	5
Involve more farmers in SRI research	2	4

CHAPTER FIVE

Discussion

5.1 Introduction

This chapter presents an analysis of the main findings from the study and existing literature. The focus of the study is on System of Rice Intensification (SRI) as a relatively new agricultural practice introduced in Mwea Irrigation Scheme (MIS) in Kenya, the delivery strategy used to promulgate SRI among rice farmers, as well as the farmers' reception towards the practice in the scheme.

The chapter will first explore awareness of SRI in MIS and the willingness of non-SRI farmers to shift to SRI. Thereafter, it will highlight and discuss the need and type of support required by the Mwea rice farmers to shift to SRI as well as the barriers and enablers to the uptake of SRI. Finally, the challenges faced by the Mwea rice farmers (that is, factors affecting the day to day livelihoods of these rice farmers) and potential solutions to address these challenges according to the farmers will be discussed.

5.2 Awareness and Willingness to Take Up SRI

Our results indicate that most rice farmers in MIS are aware of SRI. However, there is a lack of an in-depth knowledge of the practices involved in SRI amongst the Mwea rice farmers. This is evident from the inconsistent information provided by farmers regarding the basic practices embedded in SRI. Nonetheless, there is evidence of a strong willingness among non-SRI farmers to shift to SRI. SRI diffusion in MIS is highly propagated through the use of farmer-to-farmer informal social networking systems. This is because majority of the farmers claimed to have acquired SRI information from other farmers who were either relatives or neighbours that initially received SRI information from early adopters of SRI. Early adopters, also referred to as lead farmers, have been effective at diffusing information on new agricultural innovations (Padel 2001; Kassam *et al.*, 2014). For example, in their study on policy and institutional uptake of conservation agriculture in different parts of the world, Kassam *et al.* (2014) attribute most of the successful uptake of conservation agriculture to the actions of lead farmers.

Furthermore, it was observed in Kenya and Tanzania that lead farmers informally play the role of extension workers by disseminating SRI information and demonstrating SRI on their own farm parcels where other farmers can learn through observation (Mati *et al*., 2011 and Ngwira *et al.,* 2014). In MIS, our key informant interviewees briefed us on the existence of three key lead farmers in three sections, namely Tabere, Nderwa and Mwea. Consequently, this explains the high number of SRI farmers in these sections compared to the other sections. Also, this provides a reasonable explanation for increased SRI farming in Tabere despite it being the furthest section from MIAD.

However, in spite of their effectiveness at diffusing information, the informal information diffusion systems are potential platforms for information distortion. This is because no entity is in charge of controlling what information is disseminated or regulating the uniformity of this information. In this regard, this study attributes the incoherence of SRI information amongst farmers in MIS to informal farmer-to-farmer social networking systems. Additionally, such information inconsistency on SRI might have dire consequences on the farmers' livelihoods. For example, rice farmers are known to optimise on seedlings' transplanting dates in order to maximise rice yields (Baloch *et al*., 2006). Therefore, inconsistencies in information about transplanting dates might misguide a farmer to either delay or transplant seedlings earlier than is required, which in turn, might negatively affect the crop yield.

Nevertheless, Uphoff and Fernandes (2002) argue that such variability in transplanting dates amongst SRI farmers is not unusual because different practices in SRI vary by location depending on the soil and climatic conditions. In MIS, tests on seedlings transplanted between 8 and 15 days had proven successful (Nyang 'au *et al*., 2014; Ndiiri *et al.,* 2013). These authors also argue that such variabilities in information on the practices embedded in SRI are key indicators of ongoing adaptation and modifications being done on SRI by farmers globally in order to find or refine farm management practices that perfectly suit their environments. This is based on the argument that SRI is not a technology with a standard set of practices but rather a system which should be tested and verified according to local conditions (Namara *et al*., 2003; Sarker *et al*., 2015).

On the other hand, Bullen & Woods (2013) and Lockie & Rockloff (2005) also agree that inconsistencies and conflicting information about agricultural practices are not strange occurrences. They suggest that we should allow such debates to a certain extent because they trigger further research and advancement on the practice with an aim to improve compatibility of the practice with the environment. However, they issue a caveat to look out for extensive debates and incongruent information. These, they argue, can be reasonable causes to discourage adoption of a practice by potential farmers.

The willingness of non-SRI farmers to shift to SRI is shown by the number of farmers who have taken up SRI each year since its inception in MIS in 2009, and the number of non-SRI farmers who stated that they were willing to take up SRI. According to non-SRI farmers, the enthusiasm to shift to SRI is mainly driven by their desire to gain benefits of SRI which had been gained by lead farmers who had successfully increased their rice yields and minimised their water consumption by using SRI. Moreover, these farmers claimed that their drive to shift to SRI was on the condition that they receive SRI training by extension workers. An increase in the number of SRI farmers was also highlighted by Styger *et al*. (2011) who observed an increase of SRI farmers by over 200% between the 2nd and the 3rd year since SRI inception in Timbuktu, Mali. Swinton *et al.* (2015) also posits that farmer's willingness to adopt practices is driven by their desire to gain benefits from the practice. Hence, these findings correlate to our findings and those of Ndiiri *et al.* (2013) that perceived benefits of SRI are the main drivers of the willingness of Mwea rice farmers to adopt SRI.

5.3 Support Required by Farmers to Shift to SRI

As stated earlier, most non-SRI farmers in MIS are willing to take up SRI. This willingness by non-SRI farmers is however on the condition that the farmers receive formal training support. The need for SRI training support has also been reported in Zambia, Tanzania, Malawi, Sri Lanka, Nepal, and Myanmar (Namara *et al*., 2003; Kabir & Uphoff 2007; Katambara *et al*., 2013; Aune *et al*., 2014; Sigdel *et al.,* 2014). In addition to training, non-SRI farmers in MIS indicated the need for infrastructure support which they considered costly. Examples of infrastructure required include; push weeders to ease weed control, tractors to level their farms and water gauges to monitor the level of water in the rice paddies.

5.4 Barriers and Enablers to the Uptake of SRI

5.4.1 Barriers

In general, the main barriers to the uptake of SRI in the Mwea Irrigation Scheme tend to occur during the dissemination process of SRI information. Other critical barriers of SRI uptake in MIS are as a result of: the external factors, strategy used to market SRI, and farmers' individual characteristics. It was determined that the major barrier to the uptake of SRI by Mwea rice farmers is the lack of formal training.

a. Lack of formal SRI training

The lack of formal training was the most common barrier arising during SRI information dissemination. The need for training on SRI is justified by the fact that only 45% of the farmers in MIS had received formal training on SRI. Furthermore, training emerged as the most required support type by non-SRI farmers in order to shift to SRI. 44% of the farmers perceived the lack of detailed knowledge on SRI as one of the barriers to the uptake of SRI in MIS. Previously, Mati *et al.* (2011) and Ndiiri *et al.* (2013) had observed the need for training on SRI and an increasing demand for knowledge within the scheme. Ndiiri *et al*. (2013), surmises that SRI training niche in MIS had been caused by a failure to designate extension farmers who solely focused on SRI within the scheme.

Currently, in MIS, existing extension officers are employees of the Ministry of Agriculture (MOA) who are also in charge of other projects other than SRI. This has made willing farmers to become highly reliant on voluntary informal farmer to farmer training. This observation was also made by Mati *et al*. (2011) in their assessment of the development of SRI in MIS. However, according to one key informant interviewee, in an effort to remedy the situation, the Mwea Irrigation Agricultural Development Centre (MIAD) is currently increasing the farmer's capacity to train other farmers on SRI by providing training to unit leaders of the different sections within the scheme. These leaders are provided with the necessary training and support infrastructure to advocate for and support SRI farmers within their units.

Other noteworthy barriers to the uptake of SRI not interlinked with training are the high production costs, failure to involve key institutions while marketing SRI, and age of the farmer.

b. High production costs

The major barrier to the uptake of SRI attributed to external costs is high costs of production after transition to SRI. In MIS, high production costs are due to high labour and infrastructure costs. According to the farmers, labour costs for SRI are higher than those of conventional rice farming. On average, a conventional farmer's labour cost per head would amount to between Kshs. 200 to 300, whereas SRI farmers' labour costs per head would at the least amount to Kshs. 350. This is due to the fact that SRI requires more attention to detail and compliance with certain time demanding practices such as careful transplanting of each young seedling per hill and correct spacing between rice seedlings. This is contrary to conventional rice farming where rice seedlings are randomly broadcasted in the paddy and more than one seedling can be planted per hill.

In addition, farmers in MIS claimed that SRI requires more labour per acre of paddy as compared to conventional rice farming because the use of less water by SRI provides ideal conditions for constant weed growth which requires more labour. Similar studies on SRI adoption in Sri Lanka by Namara *et al*. (2003) have also confirmed that despite the 40% increase in crop yields obtained by SRI farmers, the resultant high labour costs forced some of the farmers to abandon SRI which in turn, discouraged other potential farmers from taking up the practice.

Figure 5.1. Farmers transplanting rice seedlings in a paddy in Mwea irrigation scheme, Kenya.

In the case of high infrastructure costs, the market price for a push weeder, as at the time of data collection, was Kshs. 3,000.00, which most small scale farmers considered unaffordable. In addition, farmers found it equally challenging to hire push weeders which were mostly unavailable because majority of the farmers plant around the same time. Also, most farmers considered the cost of levelling the farm (about Kshs. 4,000 per acre) in order to practice SRI as a costly and long-term investment. Hence, farmers who had leased farms with no guarantee that the lease would be renewed in the near future were reluctant to invest in SRI. Oxfam (2014) in their research for the potential for SRI in Timor-Leste also found that while the net profit of the farmers had increased significantly with SRI, the overall costs of production had also increased due to cost of weeders, labour and other additional costs required by SRI. This, in turn, made SRI appear like a costly investment to poor rice farmers with minimal income.

c. Failure to involve key stakeholders

Failure to involve key institutions like Savings and Credit Co-operative Societies (SACCOs) during SRI promotion process was observed as another barrier to the uptake of SRI. The Mwea rice farmers SACCO, now referred to as Lainisha SACCO, is the main SACCO in MIS and it holds the largest share of the rice value chain of about 4,000 farmers (Veco East Africa 2015). Farmers opt for SACCOs as market for their produce because of their favourable financial terms such as a fairly stable rice price irrespective of market price fluctuations and a range of financial services including giving capital loans to farm, education grants and health insurance policies.

Hence, the failure by SRI promoters to involve SACCO societies who are key stakeholders in rice production in MIS probably created an aura of scepticism on the validity of SRI amongst rice farmers. This creation of a barrier as a consequence of failing to involve key stakeholders during promotion of an agricultural practice has also been previously highlighted (FAO 2012a; OECD 2001).

d. Age

The major barrier to the uptake of SRI in MIS tied to farmers' individual characteristics is age. Interestingly, both the young farmers (20-39 years) and the old farmers (80 years and above) expressed similar views that age hindered them in adopting SRI compared to other farmers. Farmers in the middle age groups (40-59 years and 60-79 years) were indifferent about age as a barrier to the uptake of SRI. The older farmers claimed that SRI was tedious and time consuming because it involves a lot of monitoring, whereas young farmers argued that they were just starting out their own ventures and therefore, had smaller farm parcels compared to the older farmers. Furthermore, despite the expectation that wider spaced crops would produce higher yields, the young farmers viewed the spacing as a waste of their already limited farm space.

These findings on age concur with the observations in Nepal by Sigdel *et al*. (2014) who in their research on SRI adoption discovered that middle aged farmers had greater risk bearing capacity as compared to the young and old farmers, and which made them flexible to adopt

SRI easily. In their study on providing social and economic support to natural resource management activities in Burnnet, Byron *et al.* (2005) reported that the majority of young people were not taking up new innovations in natural resource management due to economic stability issues such as pressing family commitments, future savings and investments. Conversely, the findings on age as a barrier for older farmers to take up new innovation due to their physical abilities correlate with those of several authors (Marenya & Barrett 2007; Vanslembrouck *et al.,* 2002; Sigdel *et al*., 2014) who suggested that the increase in age diminishes the physical energy and interest to invest in new farm and natural resource management activities.

These contradicting views on age as a barrier to adoption of SRI suggests that, there is need for further analysis of specific barriers which seem to come hand in hand with age. For example, the concern of age as a barrier cited by older farmers can clearly be attributed to either the physical ability of the farmers or the nature of the practice, whereas that of young farmers could be interpreted as an economic capacity barrier or a land ownership constraint.

5.4.2 Enablers

Enablers to the uptake of SRI in MIS are tied to the farmers' perception of the benefits of SRI. This is evident from the similarity in the list of enablers provided by farmers and the list of benefits associated with SRI. Namara *et al*. (2003) also reported a direct correlation between the rate of adoption and farmers perception of benefits from SRI in Sri Lanka. Mathieu *et al*. (1992) presumes that this is because perceived enablers and barriers affect performance indirectly through impacting motivation. They give an example that when learners (in this case the Mwea rice farmers) perceive benefits, then they become motivated to learn and increase their efforts. They also believe that further effort will translate into improved performance and consequently, benefits.

On the other hand, Jack (2013) warns against relying on benefits as a standard measure to determine enablers for adoption of a practice. He argues that benefits vary from one individual to another as well as one household preference to another. Hence, benefits of SRI can be used to motivate farmers to join the practice if only the trainers make it clear the benefits that will be achieved if certain steps are adhered right. This is important because SRI is said to actualise certain benefits only when there is full adoption of all the practices embedded in SRI (Kassam *et al*., 2011; Mati *et al*., 2011).

5.5 Challenges Facing Rice Farming and Potential Solutions to Address these Challenges

The three challenges facing rice farmers in MIS in order of significance are finance, markets and water shortages.

The issues that farmers cited under finance include high cost of fertilisers and labour, limited availability of credit and microfinance services, import dumping and limited ability to expand due to lack of market and capital. For capital and credit facilities, most farmers claimed that the small number of microfinance institutions available specifically for rice farmers limited their ability to access funds to expand their production. Other farmers cited competition with non-rice farmers in the region for capital and credit facilities from financial institutions such as banks and deposit taking microfinance institution (DTMs).

Additionally, farmers also expressed their disappointment with import dumping as a result of the government's move to subsidise rice imports. Kenya imports most of her rice from Pakistan since the country is only able to meet approximately 20% of the rice demand (FAO 2012; Gitau *et al*., 2011). Moreover, as of 2014, records from the Kenya National Bureau of Statistics showed that rice imports from Pakistan attracted only 35% import duty charge while other products from other markets face a higher levy of 75% *ad valorem* rate, which has uniformly been agreed upon across the East Africa Community (EAC) (Vitale *et al*., 2013). The low rate on import duty can be presumed to be a mutual effort by Kenya and Pakistan to build their market ties. For example, in return of the 35% levy on rice, Kenya's tea exports to Pakistan face only a 5% import duty charge (Standard, 2015).

In light of this, the Mwea rice farmers claim that import dumping has forced them to further reduce the local price of rice in a bid to compete with the cheap imports, which consequently deprives the farmers of a decent income. Effects of import dumping that were cited by farmers include rice price fluctuations, broker invasion, limited market for expansion options locally and internationally, as well as brand jacking (that is, where unscrupulous wholesalers would mix local and imported rice produce, re-package and sell at a cheaper price under a local brand name). Brand jacking is done in order to attract or retain customers who prefer the local brand rice aroma over the imports.

Water shortages are said to have been mostly experienced during the months of August to September, the main planting season. Interestingly, the Mwea rice farmers claimed that a rice shortage is always expected during this time. Consequently, this creates an excessive demand for water especially in low lying areas such as Karaba and Wamumu. In fact, rice farmers in Karaba reported cases of water conflicts due to water shortages during the month of September of the previous season.

Nevertheless, SRI practising farmers in MIS claimed that SRI had since reduced their demand for water. Ndiiri *et al*. (2013) also reported water savings of up to 30% in MIS from using SRI during the main rice planting season. However, in spite of this, farmers in low lying areas within the scheme are still wary that water shortages which are known to occur from time to time due to excessive abstraction in upper regions, may occur during the wetting phase required by SRI and hence, they store water as a precautionary measure.

Currently, the Mwea rice farmers are appealing to the government to improve the road and irrigation infrastructure network, regulate the amounts of rice imports flooding the local market, and to attract microfinance investors within the area. They believe that these propositions will be key solutions to the major challenges facing rice farmers in the Mwea Irrigation Scheme.

CHAPTER SIX

Conclusion and Implications

The main aim of this study was to determine the barriers and enablers to the uptake and implementation of System of Rice Intensification (SRI) in the Mwea Irrigation Scheme (MIS) in Kenya. The study also set out to test the hypothesis whether the distance of farmers from the research centre, MIAD, is the main barrier to uptake of SRI in MIS. The objectives of the study were as follows. First, to determine SRI awareness amongst rice farmers in MIS. Second, to identify the willingness of non-SRI farmers in MIS to take up SRI. Third, to determine the need and type of support required by non-SRI farmers in order to shift to SRI. Fourth, to investigate rice farming challenges which are addressed by SRI in MIS. Fifth, to investigate the effect of the distance from the research centre (MIAD) on the uptake of SRI amongst the Mwea rice farmers. Finally, to identify the enablers and barriers to the uptake of SRI in MIS.

This study found that most farmers in MIS are aware of SRI and that non-SRI farmers in MIS are willing to shift to SRI on the condition that they receive formal training and infrastructure support. This willingness to shift to SRI is driven by the perceived comparative advantage of SRI over conventional rice farming practices. In MIS, SRI has been acclaimed to increase rice yields, economise on the use of scarce water resources and promote savings on rice seedlings, this has consequently boosted farmers overall returns.

In addition, this study has shown that the distance of the farmers from the research centre is not a significant barrier to the uptake of SRI. This is because of the existence of an effective informal information dissemination channel such that farmers located far away from MIAD, where SRI was first tried out, have knowledge of SRI. However, the overreliance on informal social networking systems to diffuse SRI information in MIS has created confusion among the farmers on the understanding of what SRI entails. This inconsistency in SRI information across MIS has been further perpetuated by the limited formal training on SRI, which has in turn become a barrier for the uptake of SRI in MIS. Other critical barriers to the uptake of SRI in MIS include high costs of production, failure to involve key institutions such as SACCO societies while marketing SRI to farmers and farmer’s age.

The study also revealed that most barriers to the uptake of SRI occur during SRI information dissemination process and that most of the barriers to the uptake of SRI in MIS are intertwined. For example, age as a barrier cited by the farmers can also be viewed as a barrier due to lack of economic capacity or physical ability whereas the barrier cited as lack of formal training can be interpreted as a lack of detailed knowledge on SRI. This implies that addressing one barrier might in turn address other interlinked barriers and that focus should not only be placed on a single barrier.

This research also found that while informal networks play a key role at disseminating SRI uptake across MIS, farmer's perceptions of the benefits of SRI are the main enablers and drivers to SRI uptake in MIS. Also, the biggest challenges facing rice farmers in MIS are lack of markets to expand as a result of import dumping, water shortages and source of finance. However, SRI eases the pressure on water demand and finance by reducing demand for water across the scheme, and there is increased income because of increase in rice yields.

To sum up, while the researcher acknowledges the important role that informal farmer to farmer networks play as entry points in promoting climate adaptation practices in communities of smallholder farmers, the researcher recommends that farmers in MIS also receive formal training on SRI. This will minimise uncertainty on the practice and motivate further uptake of SRI in MIS. I further propose that the formal training be divided into two categories. The first type of training should be addressed to non-SRI farmers with an aim to create awareness on SRI, to induct new SRI farmers and to motivate a shift to SRI. The second type of training ought to be addressed to established SRI farmers with an aim of providing continuous SRI training and disseminating new innovations made on SRI. The second training will be beneficial at reinforcing and streamlining coherence on the basic practices on SRI as well as providing a platform for feedback mechanisms between farmers and extension services within the scheme. Another recommendation is that rice farmers in MIS be provided with push weeders at a subsidised cost. This will lower the labour costs (Ndiiri *et al*., 2013) and further motivate non-SRI farmers to take up SRI.

Finally, the researcher also proposes that extension services wishing to increase the uptake of SRI should primarily focus on developing a comprehensive delivery strategy which involves formal training of SRI, this training ought to clearly inform rice farmers the specific steps to be taken in order to achieve the pre-empted benefits; to be used as motivators for

SRI uptake. Such clarity and formalness will minimise scepticism on SRI information amongst farmers which is created and perpetuated by informal information dissemination networks.

References

Abraham, B. et al., 2014. The system of crop intensification: reports from the field on improving agricultural production, food security, and resilience to climate change for multiple crops. *Agriculture & Food Security*, 3(1), p.4. Available at: http://www.agricultureandfoodsecurity.com/content/3/1/4 [Accessed May 25, 2015].

Africa Rice Center (WARDA), 2008. *NERICA : the New Rice for Africa – A Compendium ® Editors EA Somado, RG Guei and SO Keya*, Available at: http://www.africarice.org/publications/nerica-comp/Nerica Compedium.pdf.

Asfaw, S. et al., 2014. Climate Variability, adaptation strategies and food security in Malawi. Available at: http://www.fao.org/3/a-i3906e.pdf [Accessed September 24, 2015].

Aune, J.B. et al., 2014. *Opportunities for Support to System of Rice Intensification in Tanzania, Zambia and Malawi Report commissioned by NORAD under the NMBU – Norad Frame Agreement*, Available at: https://www.nmbu.no/sites/default/files/pdfattachments/noragric_report_no._71.pdf .

Baloch, M.S., Awan, I.U. & Hassan, G., 2006. Growth and yield of rice as affected by transplanting dates and seedlings per hill under high temperature of Dera Ismail Khan, Pakistan. *Journal of Zhejiang University. Science. B*, 7(7), pp.572–9. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1500883&tool=pmcentrez &rendertype=abstract [Accessed November 10, 2015].

Bera, S., 2009. A Magic Wand For Hungry Stomachs. Available at: http://www.tehelka.com/2009/05/a-magic-wand-for-hungry-stomachs/.

Bullen, K. & Woods, E., 2013. Do Farmers Adopt New Management Strategies Developed by Researchers? Do Researchers Communicate their Results Effectively? Available at: http://www.caws.org.au/awc/1999/awc199911131.pdf.

Burch, S., 2010. Transforming barriers into enablers of action on climate change: Insights from three municipal case studies in British Columbia, Canada. *Global Environmental Change*, 20(2), pp.287–297.

Byron, I., Curtis, A. & Mackay, J., 2005. *Providing social and economic data to support regional natural resource management in the Burnett Mary*, Available at: http://naturalresources.intersearch.com.au/naturalresourcesjspui/handle/1/2216.

Ceesay, M., 2011. *An opportunity for increasing factor productivity for rice cultivation in The Gambia through SRI*, Available at: http://link.springer.com/article/10.1007/s10333-010-0235-1.

Corbeels, M. et al., 2014. Understanding the impact and adoption of conservation agriculture in Africa: A multi-scale analysis. *Agriculture, Ecosystems & Environment*, 187, pp.155–170. Available at: http://www.sciencedirect.com/science/article/pii/S0167880913003514 [Accessed January 4, 2015].

Dobermann, A., 2004. A critical assessment of the system of rice intensification (SRI). *Agricultural Systems*.

Ekboir, J., 2002. Developing no-till packages for small-scale farmers. *International Maize and Wheat Improvement Center*.

Esipisu, I., 2013. *Mwea Rice Farmers Producing More Using Less Resources*, Available at: http://www.agriculturesnetwork.org/magazines/east-africa/sri/mwea-rice-farmers.

Di Falco, S. et al., 2012. Estimating the Impact of Climate Change on Agriculture in Low-Income Countries: Household Level Evidence from the Nile Basin, Ethiopia. *Environmental and Resource Economics*.

FAO, 2012a. *Conservation Agriculture and Sustainable Crop Intensification: A Zimbabwe Case Study Conservation Agriculture and Sustainable Crop Intensiication A Zimbabwe Case Study*, Available at: http://www.fao.org/ag/ca/CA-Publications/17_ZIMBABWE_LR.pdf.

FAO, 2012b. Identifying opportunities for climate-smart agriculture investments in Africa. Available at: http://www.fao.org/docrep/015/an112e/an112e00.pdf.

FAO, 2012c. *Monitoring African Food and Agricultural Policies - Analysis for incentives and disincentives for rice in Kenya*,

FAO, 2011. Save and grow A policymaker's guide to the sustainable intensification of smallholder crop production. Available at: http://www.fao.org/docrep/014/i2215e/i2215e.pdf.

Flottorp, S.A. et al., 2013. A checklist for identifying determinants of practice: A systematic review and synthesis of frameworks and taxonomies of factors that prevent or enable improvements in healthcare professional practice.

Gathorne-Hardy, A. et al., 2013. A life cycle assessment (LCA) of greenhouse gas emissions from SRI and flooded rice production in SE India. *Taiwan Water Conservancy*.

Heath, H. & Cowley, S., 2004. Developing a grounded theory approach: A comparison of Glaser and Strauss. *International Journal of Nursing Studies*, 41(2), pp.141–150.

Herrero, M. et al., 2010. Smart investments in sustainable food production: revisiting mixed crop-livestock systems. *Science (New York, N.Y.)*, 327(5967), pp.822–825.

IFAD, 2012. *Spreading the system of rice intensification across East and Southern Africa*, Available at: http://www.ifad.org/operations/projects/regions/pf/pub/SRI case study.pdf.

IPCC, 2007a. *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Available at: http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-intro.pdf [Accessed April 16, 2015].

IPCC, 2007b. *Climate Change 2007: impacts, adaptation and vulnerability: contribution of Working Group II to the fourth assessment report of the Intergovernmental Panel*,

IPCC, 2014a. Climate change 2014; Impacts, Adaptation and Vulnerability. Available at: file:///C:/Users/user/Downloads/WGIIAR5-PartA_FINAL.pdf [Accessed May 25, 2015].

IPCC, 2012. *Glossary of terms. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, Cambridge, UK, and New York, NY, USA. Available at: https://www.ipcc.ch/pdf/special-reports/srex/SREX-Annex_Glossary.pdf.

IPCC, 2014b. *Summary for Policymakers.. In: Climate Change 2014: Impacts,Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* , Cambridge University Press. Available at: https://ipcc-wg2.gov/AR5/images/uploads/WG2AR5_SPM_FINAL.pdf.

IRRI, 2013. Trends in Global Rice Consumption. Available at: https://www.scribd.com/doc/119860372/RT-Vol-12-No-1-Rice-facts#fullscreen=1 [Accessed June 30, 2015].

Jack, B.K., 2013. *Market Inefficiencies and the Adoption of Agricultural Technologies in Developing Countries* , Available at: http://sites.tufts.edu/kjack/files/2011/08/ATAI-white-paper-12102011.pdf.

Jenkins Devon, 2014. *Improving and Scaling up the System of Rice Intensification in West Africa*, Available at: https://sriwestafrica.files.wordpress.com/2014/05/benin-sri-rice-trip-report-mar-20141.pdf.

Kabir, H. & Uphoff, N., 2007. Results of Disseminating The System of Rice Intensification with Farmer Field School Methods in Northern Myanmar . , 43, pp.463–476.

Kabutha, C. & Mutero, C., 2002. From Government to Farmer-Managed Smallholder Rice Schemes: The Unresolved Case of the Mwea Irrigation Scheme. Available at: http://publications.iwmi.org/pdf/H030840.pdf.

Kassam, A. et al., 2014. The spread of Conservation Agriculture: policy and institutional support for adoption and uptake. *Field Actions Science Reports*, (Vol. 7). Available at: http://factsreports.revues.org/3720 [Accessed November 5, 2015].

Kassam, A., Stoop, W. & Uphoff, N., 2011. Review of SRI modifications in rice crop and water management and research issues for making further improvements in agricultural and water productivity. *Paddy and Water Environment*.

Katambara, Z. et al., 2013. Adopting the system of rice intensification (SRI) in Tanzania: A review. Available at: http://file.scirp.org/Html/3-3000504_35698.htm.

Laulanie, H. "The intensive rice cultivation system in Madagascar." Tropicultura 11.3 (1993): 110-114.

Lockie, S. & Rockloff, S., 2005. *Sustainable Land Management and Wetlands Conservation on Freehold and Leasehold Land in the Great Barrier Reef Landholder Attitudes to Wetlands and Wetland Conservation Programs and Incentives*, Available at: http://laptop.deh.gov.au/water/publications/environmental/wetlands/pubs/wetlands-conservation-vol-3.pdf.

Marenya, P.P. & Barrett, C.B., 2007. Household level determinants of adoption of improved natural resources management practices among smallholder farmers in western Kenya.

Mathieu, J.E., Tannenbaum, S.I. & Salas, E., 1992. Influences of Individual and Situational Characteristics on Measures of Training Effectiveness. *Academy of Management Journal*, 35(4), pp.828–847.

Mati, B.M. et al., 2011. Introduction of the System of Rice Intensification in Kenya: Experiences from Mwea Irrigation Scheme. *Paddy and Water Environment*. Available at: http://link.springer.com/article/10.1007/s10333-010-0241-3.

Mati, B.M. & Nyamai, M., 2009. *Promoting adoption of SRI in Kenya System of Rice Intensification (SRI) Growing More Rice while Saving on Water An information brochure used for Training on SRI in Mwea, Kenya*, Available at: http://imawesa.info/wp-content/uploads/2011/07IMAWESA-Training-Manual-5-SRI-Notes.pdf.

Mc Carthy, N. & Brubaker, J., 2014. Climate-Smart Agriculture and resource tenure in SubSaharan Africa. Available at: http://www.fao.org/3/a-i3982e.pdf [Accessed September 24, 2015].

Mishra, A., 2009. System of rice intensification (SRI): A quest for interactive science to mitigate the climate change vulnerability. *Earth Environ. Sci*, 6. Available at: http://iopscience.iop.org/1755-1315/6/24/242028.

MOA, 2008. *National Rice Development Strategy (2008-2018)*, Available at: http://www.jica.go.jp/english/our_work/thematic_issues/agricultural/pdf/kenya_en.pdf.

Moser, C.M. & Barrett, C.B., 2006. The complex dynamics of smallholder technology adoption: the case of SRI in Madagascar. *Agricultural Economics*, 35(3), pp.373–388. Available at: http://doi.wiley.com/10.1111/j.1574-0862.2006.00169.x [Accessed

December 28, 2015].

Moser, S.C. & Ekstrom, J.A., 2010. A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences of the United States of America*, 107(51), pp.22026–31. Available at: http://www.pnas.org/content/107/51/22026.full.

Namara et al., 2003. *Prospects for adopting system of rice intensification in Sri Lanka: A socioeconomic assessment*, IWMI. Available at: https://books.google.com/books?hl=en&lr=&id=H3HSln373B8C&pgis=1 [Accessed July 21, 2015].

Namara, R.E., Weligamage, ; P & Barker, R., 2003. The Prospects of System of Rice Intensification Adoption in Sri Lanka: A microeconomic and sociopolitical perspective. Available at: http://sri.ciifad.cornell.edu/countries/srilanka/sliwmiicid.pdf.

Ndiiri, J. et al., 2012. Comparison of Water Savings of Paddy Rice under System of Rice Intensification (Sri) Growing Rice in Mwea, Kenya (in IJCRR). *International Journal of Current Research and Review www.ijcrr.com*, 04.

Ndiiri, J.A. et al., 2013. Adoption, constraints and economic returns of paddy rice under the system of rice intensification in Mwea, Kenya. *Agricultural Water Management*, 129, pp.44–55. Available at: http://www.sciencedirect.com/science/article/pii/S037837741300187X [Accessed October 2, 2015].

Ndiiri, J.A. et al., 2012. BENEFIT-COST ANALYSIS OF PADDY RICE UNDER THE SYSTEM OF RICE INTENSIFICATION IN MWEA, KENYA.

Ndiiri, J.A. et al., 2013. Water productivity under the system of rice intensification from experimental plots and farmer surveys in mwea, kenya. *Taiwan Water Conservancy*. Available at: http://twc.bse.ntu.edu.tw/pdf/61/61-4-63-75.pdf.

Ngwira, A. et al., 2014. Adoption and extent of conservation agriculture practices among smallholder farmers in Malawi. *Soil and Water Conservation*. Available at: http://www.jswconline.org/content/69/2/107.refs.

NIB, 2015. Mwea Irrigation Scheme. Available at: http://www.nib.or.ke/schemes-stations/2015-03-20-12-15-39/mwea-irrigation-scheme.html [Accessed October 19, 2015].

Njeru, T., 2012. An Investigation into the Possibility of a Rice Gren Revolution in Sub Saharan Africa: Lessons from the Mwea Irrigation scheme in Kenya. Available at: http://ageconsearch.umn.edu/bitstream/207754/2/NjagiDissertation2012.pdf [Accessed October 26, 2015].

Noltze, M., Schwarze, S. & Qaim, M., 2012. Understanding the adoption of system technologies in smallholder agriculture: The system of rice intensification (SRI) in Timor Leste. *Agricultural Systems*, 108, pp.64–73. Available at: http://www.sciencedirect.com/science/article/pii/S0308521X1200011X [Accessed December 18, 2015].

Nyamai, M. et al., 2012. Improving land and water productivity in basin rice cultivation in Kenya through system of rice intensification (SRI). *Agricultural Engineering International: CIGR Journal*.

Nyang 'au, W.O. et al., 2014. Estimating Rice Yield under Changing Weather Conditions in Kenya Using CERES Rice Model. *International Journal of Agronomy*. Available at: http://www.hindawi.com/journals/ija/2014/849496/.

OECD, 2001. Adoption of Technologies for Sustainable Farming Systems Wageningen Workshop Proceedings. Available at: http://www.oecd.org/greengrowth/sustainable-agriculture/2739771.pdf.

Okada, M. et al., 2011. Modeling the multiple effects of temperature and radiation on rice quality. *Environmental Research Letters*, 6(3), p.034031. Available at: http://iopscience.iop.org/article/10.1088/1748-9326/6/3/034031 [Accessed December 23, 2015].

Ospina, A. & Heeks, R., 2012. ICT-Enabled Responses to Climate Change in Rural Agricultural Communities. Available at: http://www.indiaenvironmentportal.org.in/files/file/ICTs_and_Climate_Change_in_Rural_Agric_Communities_Strategy_Brief.pdf [Accessed July 29, 2015].

Otsuka, K., 2006. Why Can't We Transform Traditional Agriculture in Sub-Saharan Africa?*. *Review of Agricultural Economics*, 28(3), pp.332–337. Available at: http://aepp.oxfordjournals.org/content/28/3/332.short [Accessed November 19, 2015].

Oxfam, 2014. *System of Rice Intensification Trial and potential in Timor-Leste*, Available at: http://www.oxfam.org.nz/sites/default/files/reports/20141114_SRI in Timor-Leste report FINAL_lowres_0.pdf.

Padel, S., 2001. Conversion to Organic Farming: A Typical Example of the Diffusion of an Innovation? *Sociologia Ruralis*, 41(1). Available at: http://www.supagro.fr/capeye/wp-content/uploads/2nd_pilier/Article_Conversion_AB_Padel_01.pdf.

Pandey, S., Byerlee, D. & Dawe, D., 2010. *Rice in the Global Economy: Strategic Research and Policy Issues for Food Security*, Available at: http://books.irri.org/9789712202582_content.pdf.

Rafaralaby, S., 2002. An NGO Perspective on SRI and Its Origins in MADAGASCAR. Available at: http://sri.ciifad.cornell.edu/proc1/sri_05.pdf.

Richards, M. & Sander, B.O., 2014. *Alternate wetting and drying in irrigated rice Implementation guidance for policymakers and investors*, Available at: http://oryza.com/sites/default/files/info-note_CCAFS_AWD_final_A4_0.pdf.

Rodriguez, J.M. et al., 2009. Barriers to adoption of sustainable agriculture practices: Change agent perspectives. *Renewable Agriculture and Food Systems*.

Sarathi, P.P. & Haque, samsul, 2011. EFFECT OF SEEDLING AGE ON TILLERING PATTERN AND YIELD OF RICE (Oryza sativa L.) UNDER SYSTEM OF RICE INTENSIFICATION. *ARPN Journal of Agricultural and Biological Science*. Available at: http://www.arpnjournals.com/jabs/research_papers/rp_2011/jabs_1111_334.pdf.

Sarker, A.B.S., Islam, N. & Samad, M.A., 2015. Identification of the critical factors of System of Rice Intensification (SRI) for maximizing Boro rice yield in Bangladesh. , pp.20–24.

SCHULTZ, T.W., 1964. Transforming traditional agriculture. Available at: http://www.cabdirect.org/abstracts/19641802933.html;jsessionid=87B181AE591DD6BDFBAFE5B2B60E530A [Accessed November 19, 2015].

Sheehy, J.. et al., 2004. Fantastic yields in the system of rice intensification: fact or fallacy? *Field Crops Research*, 88(1), pp.1–8. Available at: http://www.sciencedirect.com/science/article/pii/S0378429004000036 [Accessed December 16, 2015].

Sigdel, U.P. et al., 2014. Impact of Result Demonstration on System of Rice Intensification (SRI) Adoption Among Participant and Non Participants farmers in Chitwan, Nepal. *Int. J. Agr. Ext. International Journal of Agricultural Extension*, 02(03), pp.153–158. Available at: http://www.escijournals.net/IJAE.

Siopongco, J.D.L.C., Wassmann, R. & Sander, B.O., 2013. *Alternate wetting and drying in Philippine rice production: feasibility study for a Clean Development Mechanism*, Available at: http://books.irri.org/TechnicalBulletin17_content.pdf.

Smith Barry & Olga, P., 2001. Adaptation to Climate Change in the Context of Sustainable Development and Equity. *Climate Change 2001. Impacts, Adaptations and Vulnerability.*, pp.879–906.

Standard, 2015. Standard Digital News - Kenya _ Boosting trade ties with Pakistan is important to our growth. Available at: http://www.standardmedia.co.ke/business/article/2000169890/boosting-trade-ties-with-pakistan-is-important-to-our-growth [Accessed November 30, 2015].

Stevenson, J., Serraj, Rachid & Cassman, K., 2014. Evaluating conservation agriculture for small-scale farmers in. *Agriculture, Ecosystems and Environment*, 187, pp.1–10. Available at: http://www.sciencedirect.com/science/article/pii/S0167880914000401.

Stoop, W.A., Uphoff, N. & Kassam, A., 2002. A review of agricultural research issues raised by the system of rice intensification (SRI) from Madagascar: Opportunities for improving farming systems for resource-poor farmers. *Agricultural Systems*, 71(3), pp.249–274.

Styger, E. et al., 2011. The system of rice intensification as a sustainable agricultural innovation: introducing, adapting and scaling up a system of rice intensification practices in the Timbuktu region of Mali. *International Journal of Agricultural Sustainability*.

Swinton, S.M. et al., 2015. Farmer Decisions about Adopting Environmentally Beneficial Practices. , pp.340–359. Available at: https://lter.kbs.msu.edu/open-access/citations/pdfs/3453/original/Swinton-et-al.-Ch13-Farmer-decisions-adopting-environmentally-beneficial-practices-KBS-long-term-ecological-research-LTER-site-volume-synthesis-book-2015.pdf.

Uphoff, N., 2003. Higher Yields with Fewer External Inputs? The System of Rice Intensification and Potential Contributions to Agricultural Sustainability. *International Journal of Agricultural Sustainability*. Available at: http://www.tandfonline.com/doi/pdf/10.3763/ijas.2003.0105.

Uphoff, N. & Fernandes, E., 2002. System of Rice Intensification gains momentum. *Leisa Magazine*. Available at: http://www.agriculturesnetwork.org/magazines/global/recreating-living-soil/system-of-rice-intensification-gains-momentum.

Vanslembrouck, I., Huylenbroeck, G. & Verbeke, W., 2002. Determinants of the Willingness of Belgian Farmers to Participate in Agri-environmental Measures. *Journal of Agricultural Economics*, 53(3), pp.489–511. Available at: http://doi.wiley.com/10.1111/j.1477-9552.2002.tb00034.x [Accessed October 9, 2015].

Veco East Africa, 2015. *Smallholder Farmer Organizational Models in Uganda and Kenya. Successful Models, Best Practices and Lessons*, Available at: https://eastafrica.veco-ngo.org/sites/default/files/paragraph/attachments/agric_report_revised_internet_2.pdf.

Vitale, A., Morrison, J. & Sharma, R., 2013. *FAO Commodity and Trade Policy; The East African Community Common External Tariff on Cereals: An Analysis of Stakeholder Perceptions*, Available at: http://www.fao.org/docrep/017/aq374e/aq374e.pdf.

Welch, J.R. et al., 2010. Rice yields in tropical/subtropical Asia exhibit large but opposing sensitivities to minimum and maximum temperatures. Available at:

http://www.pnas.org/content/107/33/14562.full.pdf.

World Bank, 2013. *Enhancing Agricultural Livelihoods through Community Institutions in Bihar, India*, Available at: https://www.mendeley.com/viewer/?fileId=0df67d1a-003e-6661-70b3-079ecbcb5ca4&documentId=08bb6956-c22d-3d9c-b613-36944f69de2e.

World Bank, 2007. *World Development Indicators*, Available at: https://www.mendeley.com/viewer/?fileId=38b6f537-7475-3bec-2e0a-810d9ece3f1e&documentId=4c547fa8-0b04-3192-9abf-abd46f87b99f.

Yue, J. et al., 2005. Methane and nitrous oxide emissions from rice field and related microorganism in black soil, northeastern China. *Nutrient Cycling in Agroecosystems*.

Zhao, L. et al., 2009. Influence of the System of Rice Intensification on Rice Yield and Nitrogen and Water Use Efficiency With Different N Application Rates. *Experimental agriculture*, 45(3), pp.275–286. Available at: http://dx.doi.org/10.1017/S0014479709007583.

Zhao, L. et al., 2011. Nutrient uptake and water use efficiency as affected by modified rice cultivation methods with reduced irrigation. *Paddy and Water Environment*, 9(1), pp.25–32.

APPENDIX I

Questionnaire

Date:

Terms of Reference

The researcher hereby confirm that;

1. This research is undertaken with a purpose towards partial fulfillment of the degree MSc. Climate Change and Development at University of Cape Town, South Africa

2. That the respondent to this questionnaire will remain anonymous and that no name of any respondent will appear on my thesis report.

3. Data will be provided by the respondent on a voluntary basis and that a respondent has the right to terminate the process at any time if they no longer wish to continue with the process.

Kindly sign below to indicate consent that the researcher can use the information provided herein

____

I. General Information

Name: ____

Profession: ____

Mobile No.__________________________

Email Address_______________________________

Attained level of Education ☐ Primary and below ☐ Above Primary

Age: ☐ Below 25years ☐ 25 to 35 ☐ 35 to 45 ☐ Over 45 years

Gender Female ☐ Male ☐

Language: working proficiency ____

1. Are you a part time or a full time farmer? ____________________________________

2. Is farming your main source of income? ☐ Yes ☐ No

   a. If No above, what are your other sources of income? ______________________.

   b. If Yes above, would you say your income from rice farming is profitable?

   Yes ☐ No ☐

3. What is the approximate size of the farm in Acres/hectare ______________________.

4. On average how many Kilograms of rice do you produce in a season _______________.

5. Do you own the farm you are currently cultivating ☐ Yes ☐ No

7. If NO in 5 above, do you have a farm of your own? ☐ Yes ☐ No

8. Approximate distance of your farm from Mwea Irrigation Agricultural Development and Research Centre:

☐ 0 – 15Km ☐ 15 – 25km ☐ 25 – 35km ☐ Over 35Km

II. Rice farming practices and SRI Awareness

9. Do you know what System of Rice intensification is? ☐ Yes ☐ No

b. If YES above, please give a brief description

____

____.

10. Do you know the advantages and disadvantages of SRI?

☐ Yes ☐ No

b.) If Yes above, where did you get this information from _____________________________

c.) In what language was this information communicated? _____________________________

d.) If YES in 10 above, kindly list some of the advantages and disadvantages of SRI

Advantages	**Disadvantages**
_________________________________	
__________________________________	_________________________________
__________________________________	_________________________________
__________________________________	_________________________________

11. What is your current rice farming method?

☐ Conventional ☐ A Mix of SRI and Conventional ☐ SRI

b. Kindly, give a brief description of your current rice farming method as above chosen.
   ____
   ____

c. Why did you opt for this method of rice farming?
   ____
   ____

d. What are the advantages and disadvantages of using this method of rice farming?

   ____
   ____

e. For how long have you been using this rice farming method? And who taught you?

   ____

12. If you **chose SRI in question 11** above.

a. How long have you been using SRI? ______________________________.

b. Why did you shift to SRI?

____

____

c. Did you receive any support to shift to SRI?

Yes ☐ No ☐

If Yes above, briefly Explain the type of support and from whom and how long

____

____

____

d. Are there any changes that you have experienced in your production ever since the shift to SRI?

☐ Yes ☐ No

If Yes above, Briefly Explain

____

____

e. Overall, would you say this method provides higher your output or income as compared to conventional rice farming?

☐ Yes ☐ No

Briefly explain your answer above

____

____

f. If lack of water resources was the main reason you shifted to SRI, If there was enough water resources for rice irrigation, would you still opt for SRI?

____
____

III. FARMERS PERCEPTIONS AND WILLINGNESS TO ADOPT SRI

13. If given a choice which would be your preferred practice of the three

☐ Conventional ☐ A Mix of SRI and Conventional ☐ SRI

Give reasons
____
____

14. If Not indicated SRI as you your current and preferred method above, briefly explain why you did not opt for SRI

____
____

15. Currently, what are the biggest challenges affecting rice farming?
____
____

a. What do you think could help overcoming the challenges?

____
____
____

b. Do you think SRI has helped overcome some of these challenges?

☐ Yes ☐ No

If Yes, briefly explain how

____
____
____

c. IF NOT using SRI, Would you be willing to use SRI on your farm?

☐ Yes ☐ No

Briefly explain your answer above

____
____
____

16. If yes in 15c above, kindly provide a list of resources you might need to shift to SRI
____
____
____
____

17. Tick appropriately

List of Potential Barriers to Uptake of System of Rice intensification

1. Lack of Awareness of the practice ☐
2. Limited practical training time ☐
3. Language barrier ☐
4. Farmers are seen as adopters other than partners ☐
5. Initial high cost of implementation ☐
6. Lack of infrastructure (irrigation systems, roads, machinery) ☐
7. Distance from support services (MIAD offices) ☐
8. Limited size of land parcel to produce ☐
9. Lack of institutional support (NIB, SACCO, GOVT) ☐
10. Gender constraints ☐
11. The practice does not increase yields and ☐
12. The practice does not provide savings on seeds ☐
13. The system does not provide immediate benefits ☐
14. Lack of expansive markets to market the produce ☐
15. Any other ☐

List of potential enablers to the uptake of System of rice intensification

1. Favorable institutional/governmental support ☐
2. Sufficient information of the practice ☐
3. Support services from researchers and Extension farmers ☐
4. Availability of proper infrastructure ☐
5. Proximity to support centers ☐
6. The practice increases rice yields ☐
7. High income/ profits from the practice ☐
8. Savings from the practice ☐
9. Low costs of implementing the practice ☐
10. Lack of a better alternative system ☐
11. SRI reduces emissions into the atmosphere ☐
12. SRI has integrated some prior existing traditional methods ☐
13. SRI is a suitable water conservation method ☐
14. Any other ☐

~ Thank you ~