INFLUENCE OF RICE INTENSIFICATION SYSTEM ON RICE PRODUCTION AMONG SMALL SCALE FARMERS. CASE OF TEBERE IN MWEA, KIRINYAGA COUNTY IN KENYA

By:

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DECLARATION

This research project report is my original work and has never been presented by anyone else for academic credit.

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DEDICATION

This work is dedicated to my loving mother Catherine Nyawira for her moral support throughout the course.

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LIST OF ACRONYMS AND ABBREVIATION

SRI - System of Rice Intensification

IMAWESA - Improved Management of Agricultural Water in Eastern and Southern Africa

SPSS - Statistical Package for Social Science

HYV - Higher Yielding Varieties

NIB - National Irrigation Board

MOA - Ministry of Agriculture

MMRG - Mwea Multi-purpose Rice Growers

MIAD - Mwea Irrigation Agricultural Development

MDG - Millennium Development Goals

BNF - Biological nitrogen fixation

ATS - Association Tefy Saina

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ABSTRACT

Rice consumption has been increasing more rapidly than production over the years thus increasing rice imports/consumption ratio by about 6% over the years with Thailand accounting for 74% of all imports. The gap will continue to increase with increased population. There is therefore an urgent need for improved rice practices that will ensure rice sufficiency and security. This study investigated the influence of rice intensification system developed in the early 1980ós in Madagascar by Father Henri de Laulaníe on rice production among the small scale rice farmers of Tebere in Mwea Constituency, Kirinyaga County. It involves applying certain identified agronomic management practices which allow better growing conditions for rice plants, particularly in the root zone than those for plants grown under traditional practices. The main objective of the study was to establish the rice management practices among the farmers and how they influence rice production. The study used descriptive research survey where data was collected through self administered questionnaires with open ended and closed questions. Two stage cluster random sampling was used to identify the respondents drawn from a sample size of 368 as determined by Krejcie and Morgan table. The data collected was analyzed using Statistical Package for Social Science (SPSS). The response rate was 96.2% with 65.5% male and 34.5% female representation. Most of the respondents used SRI practices though some mixed the SRI practices with the conventional practices. Majority of the respondents, 84.7% were partial SRI adopters while the rest had either abandoned it or had never adopted it. The study found positive perception of SRI among the respondents. From the cross check done, 52.3% of the respondents indicated having much higher rice yield after SRI and 97.5% of the respondents were satisfied with SRI. The study concluded that rice management practices, farmersô awareness on system of rice intensification, adoption of system of rice intensification and farmersô perception of system of rice intensification to a great extent influence rice production. The study recommended there be good management of Mwea Multipurpose rice growers and National Irrigation board to ensure good service delivery to the farmers. Additionally, the study suggested further research on: new methods of controlling birds in rice fields; proper land leveling techniques for rice cultivation and ways of facilitating farmersô access to cheap farm inputs like machinery to improve rice produce.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Globally, rice is one of the most important food crops in the fight against hunger. Unlike maize and wheat that are consumed as human and livestock feed, rice remains the most favored grain globally for human consumption especially in Asia and the West Indies (Ito, 2002). It provides almost 50 percent of the calorie requirement supplied by the cereals (Pokhrel 1997). An average person eats about 300 to 400 pounds (130-180kg) of rice per year. East Asia produces 45% of world rice production while South Asia 24%, South East Asia 22%, Latin America 4%, Africa 2% and the rest of the world 3%. The top ten in the world rice production are China (143,000 metric ton), India, Indonesia, Bangladesh, Vietnam, Thailand, Philippines, Myanmar, Brazil and Japan (7500 metric ton), (Isrankura, 1966) and (Liu and Froyen, 2012). However, rice production needs to be increased in order to meet the food demand of growing populations (Bouman et al. 2007). Continued increase in population has created an alarming need for more rice (Surridge, 2004). Farmers have to grow 50 percent more rice in 2025 in order to assure food security in rice-consuming countries and the production should be on less land with less water, less labor and less chemical fertilizers (Zheng et al.2004)

Several innovations have been made with rice systems in order to increase grain yield, productivity and better meet the worldôs food demand. One of the achievements was the Green Revolution which refers to a series of research, development, and technology transfer initiatives to increase agriculture production worldwide (Gabreselassie, 2006). It involved the development of high-yielding varieties of cereal grains, expansion of irrigation infrastructure, modernization of management techniques, distribution of hybridized seeds, synthetic fertilizers and pesticides to farmers (Gabreselassie, 2006).

The ñGreen Revolutionò has produced tremendous yield increases in Asia, where many farmers have been able to adopt the technology. It was introduced to intensify rice production through Higher Yielding Varieties (HYV), chemical fertilizers and pesticides (Greenland, 1997).

As a result the worldôs production of rice doubled in the periods of the 1960ôs to the 1980ôs (Tsujimoto et al., 2009) However, the Green Revolution failed to help many farmers in Africa who are constrained by their limited infrastructure and financial resources. In this regard scientists are pursuing genetic research for further improvement thus raising new issue of how resource-poor farmers can improve their rice yields and participate in a hunger-relief program (Otsuka and Larson, 2013).

The other achievement for meeting the high demand was the System of Rice intensification (SRI) which was developed during the early 1980ôs in Madagascar by Father Henri de Laulaníe, a Jesuit priest who spent over 30 years in that country working with farmers as a low input system for resource poor farmers (Stoop et al., 2002). It involves changing how we manage the soil, water, nutrients and the rice plant which together provide better growing conditions for rice plants, particularly in the root zone than those for plants grown under traditional practices as well as improved/ higher yields (Association TefySaina, 1992). Seedlings are transplanted early (between 8 and 15 days), planted singly rather than in clumps, wide spacing (at least 25 cm x 25 cm) and use of compost from any biomass as opposed to the use of chemical fertilizers (Tsujimoto et al, 2009).

In System of Rice Intensification (SRI), there exists a substantial genetic potential that can be effectively tapped by adjusting the agronomic management practices. Association Tefy Saina, which has pioneered the work on SRI in Madagascar, has shown that SRI practices will double production for practically all of the rice varieties, local or improved. Agro-ecological methods of crop production appear to give better results with genetically-improved varieties. Some varieties have a greater potential for tillering, root growth and grain filling than others in response to wide spacing, aerated soil, and other SRI practices (CIIFAD, 1999).

SRI innovation is guided by participatory involvement (organization coalitions), stressing on diversity and complementarities (Satyanarayana, A. 2005). This includes the participation of society-institution actors who become engaged on the basis of their interest, expertise and values rather than authority. The initiative has come from one sector or another and is passed on informally to whichever institution to get started. The participation is open to any sector which includes: NGOs, Universities, research institutions, government agencies, farmersô organization and private sector (Satyanarayana, A. 2005).

In 1990, Association TefySaina (ATS) was formed as a Malagasy NGO to promote SRI. Four years later, the Cornell International Institute for Food, Agriculture and Development (CIIFAD), began cooperating with TefySaina to introduce SRI around the Ranomafana National Park in eastern Madagascar, supported by the United States Agency for International Development. It has since been tested in China, India, Indonesia, the Philippines, Sri Lanka and Bangladesh with positive results (Uphoff, 2005).

SRI differs from rain-fed traditional/conventional rice systems in several ways. The two main differences are: i) Transplanting only one younger seedling per hill and, ii) Proper water management by decreasing and increasing the water table in a specific pattern (Laulanie, 1993). This water management involves moist soil during the vegetative stage, flooded during the panicle stage and total drainage of the field two weeks before harvest (Sheehy et al., 2004). SRI increases rice yields remarkably through fewer inputs and improvement of soil quality over time from amendments of organic materials (Uphoff, 1999; Stoop et al., 2002; Kabir, 2006) (Satyanarayana et al., 2007).Whereas SRI is based on different management techniques, it also relies heavily on farmersô skills and investments of labor (Uphoff, 1999).

The first SRI trials in China were undertaken at Nanjing Agricultural University by Dr. Cao Weixing followed by evaluations at the China National Hybrid Rice Research and Development Center at Sanya under the direction of Prof. Yuan Longping. The results indicated considerable water saving through modified SRI and a reduction of seed costs, but no significant increase in yields (Thiyagarajan 2002). These initial results did not discourage farmers but instead sought more information from farmers who had successfully practiced SRI sponsored by Cornell International Institute for Food, Agriculture and Development (CIIFAD) (Thiyagarajan 2002).

The Rice Intensification System (SRI) was introduced in Pakistan's Sheikhupura district by the LokSanjh Foundation (a non-profit foundation working with rural communities) about five years ago (Uphoff et al. 2002). As many as 300 farmers in 65 villages between Sheikhupura and Sialkot have reportedly adopted the SRI method of rice cultivation. Majority of the farmers using organic SRI methods (80%) have noted many benefits, including the use of less water and stronger roots which prevent lodging and crop loss and seasonal fungal and pest attacks (Uphoff et al. 2008). According to LokSanjh CEO Shahid Zia, the cultivation of SRI crop produces around five to ten pounds more than traditional rice crops per yield as a result of lower grain loss due to heavy winds.

In Kenya, SRI was formally launched in a meeting of stakeholders held at the headquarters of the Mwea Irrigation Scheme, Kirinyaga County on August 18, 2009. The meeting was organized by Bancy Mati, program manager of Improved Management of Agricultural Water in Eastern and Southern Africa Network (IMAWESA) and Jean Njiru, with assistance from Markus Wolfe, irrigation specialist in the World Bank office in Nairobi. The Field experiments conducted in 2010/2011 at Mwea Irrigation Agricultural Development (MIAD) of Mwea Irrigation Scheme (MIS) showed that SRI methods gave the highest water-saving and yields (Mati, B. M. 2011).

1.2 Statement of the Problem

Rice consumption has been growing much more rapidly than production throughout the nearly 50 years since independence. Increasing consumption with decreasing production has led to increased imports/consumption ratio. The imports are mainly from Thailand, Pakistan and India with Pakistan accounting for 74 percent of total rice imports during the period 2006-2010. (Imports: MOA ERA production and consumption 2005-2010). The growth in consumption appears to have slowed to 3 percent per year since 2005, but the dependency ratio for the decade remains at 88 percent. The gap will continue to increase with increased population. There is therefore an urgent need to adopt practices that will improve food security and rice sufficiency at a reduced cost. Table 1.1 shows that rice yield in respect to the area cultivated has been decreasing over the years between 2005 and 2010. It shows the increasing gap between rice production and consumption and high dependency levels on imports which will continue to increase with increasing population. Kenyaô population has been growing over the years with an average of 1% per year. In 2013, the population was 44.35M as compared to 40.91M in 2010 (World Bank)

Table 1.1 Milled Rice Production, Area and Yield Rice consumption, Imports and import dependency in Kenya, 2005-2010

	2004/5	2005/6	2006/7	2007/8	2008/9	2009/10
Production (tones)	39,173	39,366	33,196	25,041	23,249	45,313
Area (Ha)	10,832	12,501	9,626	9,092	10,072	17,611
Yield (T/a)	3.6	3.1	3.4	2.8	2.3	2.6
Production	57,942	64,840	47,256	21,881	42,202	45,313
Imports	228,206	232,305	261,712	299,070	308,158	284,368
Exports	n.a.	801	597	1,481	2,310	1,640
Apparent consumption	279,800	296,344	308,371	319,470	348,050	328,041
Imports/consumption ratio	80%	78%	85%	93%	87%	86%

Source: MOA ERA production consumption and imports 2005-2010. CountryStat website 2005-2010 production

There are five National Irrigation schemes currently producing rice in Kenya. Mwea in central Kenya is by far the largest, accounting for 78% of the irrigated area, 88% of production and 98% of the gross value of output between 2005 and 2010, according to NIB data. The other four rice producing schemes are Ahero, Bunyala Perkerra and West Kano (Table 1.2) Table 1.2 shows the five irrigation schemes with their respective cropped hectares, yields and gross value output between 2006/07 - 2011/2012. Mwea irrigation scheme has had the highest number of yields over the years.

Table 1.2 Irrigation Schemes, 2006/07 - 2011/2012

	2006/7	2007/8	2008/9	2009/10	2010/11	2011/12
MWEA						
Hectares cropped(ha)	8,325	7,806	7,431	10,526	10,629	10,629
Paddy yields (Tonnes)	51,458	38,560	32,406	52,000	54,000	50,476
Gross value of output (KSh millions)	1,544	2,121	1,782	2,860	2,970	2,808
AHERO						
Hectares cropped(ha)	623	-	1,568	1,215	1,215	1,215
Paddy yields (Tonnes)	851	-	2,939	6,000	6,000	9,484
Gross value of output (KSh millions)	29	-	103	330	330	350
PERKERRA						
Hectares Cropped(ha)	527.00	1,941	579	729	729	237
Paddy yields (Tonnes)	1,945.9	2,674	1,720	1,916	1,916	2,551
Gross value of output(KSh millions)	69.4	103	11	155	155	173
BUNYALA						
Hectares cropped(ha)	623	236	534	648	648	682
Paddy yields (Tonnes)	682	567	1,161	3,200	3,200	5,462
Gross value of output(KSh millions)	23	11	36	176	176	202
WEST KANO						
Hectares cropped(ha)	233.0	1,000	714	911	911	1,299
Paddy yields (Tonnes)	124	938	692	4,500	4,500	8,910
Gross value of output (KSh millions)	8	28	-	248	248	329

Source: Statistical Abstract 2013. Kenya National Bureau of Statistics

Mwea is by far the largest ward as shown by Table 1.3 below, accounting for 75.6% of the irrigated area, 65.7% of production and 72.7% percent of the gross value of output in 2012. The National Irrigation Board (NIB) in Mwea has concentrated on empowering the farmers through training. Despite the efforts, many rice farmers in Mwea are still using the traditional/ convectional/normal management practices. The main source of water for irrigation in Mwea comes from river Thiba and Nyamindi. Despite NIB aiming at managing water in the main and secondary canals, water sufficiency is adversely affected during the dry season when the riversô water level reduces thus affecting irrigation. The annual rainfall in Mwea ranges from 356-1626mm with an average of 950mm.

Table 1.3 Irrigation Schemes 2012

Scheme	Irrigated area (ha)	% area	Yields (tones)	% yields	Gross value output (Ksh Millions)	% gross value output
Mwea	10,629	75.6%	50,476	65.7%	2,808	72.7%
West Kano	1299	9.2%	8,910	11.6%	329	8.5%
Ahero	1215	8.7%	9,484	12.3%	350	9.1%
Bunyala	682	4.8%	5,462	7.1%	202	5.2%
Perkerra	237	1.7%	2,552	3.3%	173	4.5%
Total	**14062**	**100**	**76,883**	**100**	**3,862**	**100**

Mwea Irrigation Scheme (MIS) and a local farmersô cooperative society, the Mwea Multi-Purpose Rice Growers (MMRG) have undergone various institutional and management changes that have negatively affected the provision of services. The inability to render services has impacted on the provision of production inputs like the fertilizers, herbicides and pesticides.

System of rice Intensification (SRI) involves the use of certain management practices which together provide better growing conditions. It changes how we manage the soil, water, nutrients and rice plant thus enabling farmers overcome challenges of water and inputs shortages. The System of rice intensification has generated interest and discussions among researchers and development practitioners in Kenya which has often resulted in opposing views. Some proponents claim that it will transform the method of rice production, while others see it as a fad. Studies in Africa, Asia and Latin America provide mixed results. Most of these studies are not based on facts and instead limited to experimental and demonstration activities. Almost no studies have been carried out on influence of rice Intensification System on rice production in Kenya. This study contributes to filling this research gap based on Tebere, Mwea Kirinyaga county farmers. This study aimed at: investigating how farmers awareness of SRI influences rice production; establishing the rice management practices among the farmers and how they influence rice production; determining how the adoption of SRI as compared to normal practices influences rice production; assessing how farmers perception of SRI influences rice production.

1.3 Purpose of the study

The purpose of this study was to investigate the influence of system of rice intensification on rice production among the small scale rice farmers with special reference to Tebere, Mwea Kirinyaga County.

1.4 Objectives of the study

1. To identify the rice management practices among the farmers and how they influence rice production.
2. To determine how farmers awareness of System of rice Intensification (SRI) influences rice production.
3. To determine how the adoption of System of rice Intensification as compared to normal practices influences rice production
4. To assess how farmers perception of System of rice Intensification influences rice production.

1.5 Research Questions

1. Does the rice management practices used by the farmers influence rice production?
2. How does the farmersô awareness of System of rice Intensification influence rice production?
3. To what extent does the adoption of System of rice Intensification practices as compared to normal practices influence rice production?
4. Does the farmersôperception on System of rice Intensification influence rice production?

1.6 Significance of the study

The study aims at providing insight to Ministry of Agriculture and the rice farmers on the influence that the system of rice intensification has on small scale farmers. The insight will enable the farmers overcome some of the major challenges they face which includes harsh weather conditions, pests and weeds, insufficient water supply and high input costs. The findings will also encourage rice farmers to adopt a system with higher yields that will match the increasing demand of rice consumption with Kenyaǿs rapidly growing population. The results of the study will be important to researchers and scholars, as it will form basis for further studies.

1.7 Limitation of the Study

Some of the respondents were semi-illiterate or illiterate hence unable to complete the questionnaires on their own. This led to more man hours spent by the research assistants interpreting and filling in the questionnaires for the respondents.

There were differing responses on the yields between farmers who planted recycled rice seeds and those who planted fresh rice seeds under the same growing conditions. This was because some farmers preferred to recycle seeds from their previous harvest instead of buying expensive quality seeds from trusted sources which is mainly contributed by mismanagement of MIS and MMRG leading to inaccessibility of the quality seeds. One therefore needs to generalize the findings with caution as these conditions may be unique for Mwea Irrigation Scheme.

1.8 Delimitation of the study

The study mainly focused on rice growers in Tebere, Mwea Kirinyaga County and generalizations were made to all other small scale rice growing areas. Mwea Tebere is one of the largest irrigation schemes in East and Central Africa.

1.9 Assumptions of the Study

The researcher assumed that the rice farmers will cooperate with her and provide all the pertinent information required. The researcher also assumed that the farmers have the skills and knowledge of the system of rice intensification. Further, there was an assumption that factors influencing small scale rice farming in Tebere, Mwea Kirinyaga County are similar to those in other rice growing areas in Kenya and other parts of the world.

1.10 Definition of significant terms.

Early Transplanting ï Transplanting is the moving of young seedlings from the nursery to the field. Early transplanting is planting seedlings younger than 15 days which shall encourage tillering, reduce the transplanting shock, and extend the cropping cycle.

Inter-cultivation ï Is the cultivation of soil between crop rows

Intermittent irrigation ï It is saturating rice fields instead of continuously flooding them. That is, alternate wetting and drying. This water saving method minimizes anaerobic conditions, which hamper the growth of roots and soil organisms affecting plant architecture and canopy structure.

Labor-intensive- Requiring or using large supply of labor relative to capital.

Mono-rice culture ï Is the growing of rice plant only over a wide area and a number of years.

Rice Production ï Is a process of combining various material inputs (seed, water, manure, labor, land) and immaterial inputs (plans, know how) in order to make rice (Output).

Single seedling ï It is the planting of single young rice plant per hill. This enhances tillering and root system development thus leading to increased drought tolerance and more efficient nutrient uptake.

System of rice intensification ï A system that involves the use of certain management practices which together provide better growing conditions. The practices include; early single transplanting, intermittent irrigation, wide spacing and use of organic nutrients.

Wide spacing- Planting rice plants in a square pattern with a minimum distance of 20 x 20 cm. Together with single seedlings this practice increases the exposure of plants to sunlight, air, and nutrients.

1.11 Organization of the study

This research project report is organized in five chapters. Chapter one forms part of the introduction of the study and illustrates the background of the study, the statement of the problem, objectives of the study and research questions. Chapter two contains literature review which is divided into two sections; Empirical and conceptual framework. The Empirical review is composed of past studies which are related to rice farming. The conceptual framework contains the variables and their relation to rice production.

Chapter three explains the research methodology. This chapter outlines the research design, target population, sampling procedure and sample size, data collection instrument and shows how the data was analyzed.

Chapter four contains data presentation, analysis and interpretation while chapter five contains summary of the Findings, Discussions, Conclusions and Recommendations. The references mostly contain the journals reviewed and other sources such as books and websites. There are four Appendixes; letter of introduction, Questionnaires, map of Tebere irrigation scheme and Krejcie and Morgan table.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides a theoretical review on the study supporting theories, rice growing strategies and performance, rice production frontier and contextual factors. Empirical review and its summary as wells as the conceptual framework is explained through exploration of the past research studies on SRI. It provides an overview of some of the scholarly contributions on the field of rice production and the influence of SRI. It identifies the gaps that the proposed study will try to address.

2.2 Empirical Framework

System of Rice intensification (SRI) was developed during the early 1980ȏs in Madagascar by Father Henri de Laulaníe, a Jesuit priest (Stoop et al., 2002). The first SRI trials in China were undertaken at Nanjing Agricultural University by Dr. Cao Weixing followed by evaluations at the China National Hybrid Rice Research and Development Center at Sanya under the direction of Prof. Yuan Longping. The results from the trials encouraged farmers to seek more information from farmers who had successfully practiced SRI sponsored by Cornell International Institute for Food, Agriculture and Development (CIIFAD) (Thiyagarajan, 2002). The results indicated considerable water saving through modified SRI and a reduction of seed costs (Thiyagarajan, 2002).

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In Kenya, SRI was formally launched on August 18, 2009. The Field experiments conducted in 2010/2011 at Mwea Irrigation Agricultural Development (MIAD) of Mwea Irrigation Scheme (MIS) showed that SRI methods gave the highest water-saving and yields (Mati, B. M, 2011).

2.3 Rice management practices and rice production

Traditional/ conventional method for cultivating rice involves flooding the fields while or after random transplanting the young seedlings.SRI on the other hand involves alternating drying and flooding and transplanting young seedlings in rows. These SRI management practices together provide better growing conditions for rice plants, particularly in the root zone than those for plants grown under traditional practices.

2.3.1 Mode of planting

Under conventional method, seedlings are transplanted at a rate of two per hole and 20 x 20cm spacing and the water level is raised to an average depth of 5cm immediately thereafter. Ten days after transplanting, gapping is done to replace dry or weak seedlings. Under SRI, 8 ï 15 day old seedlings with 3 leaves are grown in a raised nursery bed. Single seedlings are planted with a minimum time interval between the time they are taken out from the nursery and planted carefully at a shallow depth (1-2 cm). Planting at grids of either 20 x 20 cm or 25 x 25 cm (or 30 x 30 cm or even wider if the soil is very fertile) using a rope or roller marker to achieve precise inter-plant distances to facilitate inter-cultivation, (Gujja at al, 2013).Transplanting single young seedlings has the following benefits: Much greater potential for tillering and root growth; Earlier arrival within a better growing environment in the main field extends the time for filleting; No transplanting shock if transplanting is done carefully; No competition for nutrients, water and space within a hill; Seed requirements are reduced and wider spacing enables all leaves to be photo synthetically active unlike with crowding where lower leaves do not get enough exposure to sunlight for photosynthesis.(Sharif,2009).

2.3.2 Water management

Up to panicle initiation, one irrigates 2.5 cm depth after the water ponded earlier disappears and hairline cracks are formed on the soil surface. (Heavy clay soils should not be permitted to reach the cracking stage, but still are issued less water than with usual flooding.) After panicle initiation, irrigation is done to a depth of 2.5 cm one day after the water ponded earlier disappears. Moist and un-flooded water management regime has the following benefits: Non-hypoxic condition of soil favors root health and functioning and supports more abundant and diverse communities of beneficial aerobic soil organisms; No degeneration of roots, which otherwise will be as much as 75% degraded by panicle initiation under flooding; Exposing the soil to sunlight is favorable for warmth; Water savings of up to 40% and Energy saving where water is pumped. SRI requires moist but un-flooded soil conditions. Rice has traditionally been grown submerged in water. This standing water however creates hypoxic soil conditions (lacking in oxygen) for the roots and hardly seems to be ideal! Rice roots have been shown to degenerate under flooded conditions, losing ¾ of their roots by the time the plants reach the flowering stage. This die-back of roots under flooded conditions has been called "senescence," implying that it is a natural process. But it actually represents suffocation, which impedes plant functioning and growth. The soil should occasionally be allowed to dry to the point of cracking thus allowing oxygen to enter the soil and also induce the roots to grow and "search" for water. After all, when the soil is flooded, roots have no need to grow and spread, and they lack enough oxygen to grow vigorously. (ATS, 1992; Vallois, 1996).

2.3.3 Weeding method and interval

Weeding can be done by hand or with a simple mechanical hand weeder developed by the International Rice Research Institute in the 1960s. It has vertical rotating toothed wheels that churn up the soil as the weeder is pushed down and across the alleys formed by the square formation of planting (Uphoff et al., 2009). The first weeding should be done ten to twelve days after transplanting, and the second within fourteen days (Uphoff et al., 2009). At least two or three weeding are recommended but another one or two can significantly increase the yield. Weeding not only removes weeds but also improves soil structure and increase aeration of the soil when churning the soil (Association TefySaina, 1992).

2.3.4 Type of Manure

SRI was developed initially with chemical fertilizers to increase yield on the very poor soils of Madagascar. But when subsidies were removed in the later 1980s, recommendations switched to use of compost, and even better results were observed (Menete et al. 2008). The compost can be made from any biomass (e.g. rice straw, plant trimmings and other plant material), with some animal manure added if available. Banana leaves can add more potassium; cuttings from leguminous shrubs add more nitrogen (Uphoff, 2008). Compost adds nutrients to the soil slowly and can also contribute to a better soil structure. Some form of nutrient input is necessary on poor soils if chemical fertilizer is not added. Organic manures, farm yard manure and vermin-compost are incorporated into the soil two weeks before planting (Uphoff, 2009).

Application of cattle manure, green manure, bio-fertilizers, and vermin-compost is recommended. Chemical fertilizer can be used, but it does not have the same beneficial effects on soil systems (Stoop et al. 2002). Biological nitrogen fixation (BNF), free-living bacteria and other microbes around the roots of rice may fix nitrogen for the plants. However, less nitrogen fixing occurs where chemical fertilizers have previously been applied. It is known that about 80% of the bacteria in and around rice roots have nitrogen-fixing capability, but this potential will not be realized where inorganic N has been applied, or possibly in anaerobic, water-logged soil. (Uphoff, 2009).Plants can grow very well with extremely low concentrations of nutrients, as long as those nutrients are supplied evenly and consistently over time. In this regard, compost furnishes a low, steady supply of nutrients.

SRI is a labor-intensive system (Moser & Barrett, 2003) and requires irrigation facilities in order to work properly (Sinha&Talati, 2007). The access and availability of organic materials may also pose problems (Dobermann, 2004) for full scale adoption by small scale farmers.

2.4 Farmers' Awareness of system of rice intensification and rice production

Farmersô awareness of SRI is defined as farmers having knowledge of SRI. The awareness can be gained through training, field demonstrations, cross visit, individual visit by extension workers, leaflet/ magazine, farmer promoter/ key farmer, individual from another farmer and mass media. There is need for good information flow and information sharing among agricultural stakeholders for better professional update and improved produce (Joel, 2011).

Information is a means of transferring events for better awareness to add new meaning that could change events, lives or experiences. Awareness and use of information produces knowledge (Low, 2000). Dissemination of adequate information literacy to the grass root farmers will enhance productivity (Fortin and Pierce, 1998). Rice farmers face the challenge of assessing useful information through different media, practical hand-on experience and better direction since they are based in the rural areas. Unimpeded information flow among rice farmers would influence rice produce and storage in large quantity all year round. Interpersonal connectivity between farmers and agricultural extension agents enhances farmersô information literacy, knowledge and awareness of current trend in farming practices that boosts stages of farming and abundance output supply (Sokoya, Onifade and Alabi, 2012). SRI was formally launched in Mwea on August 18, 2009. SRI awareness enables and encourages participants to adopt the various SRI techniques where the benefits are widely known.

2.5 Adoption of System of rice intensification as compared to normal practices and rice production

Adoption is the extent of use of a new technology or innovation. Adoption takes place in long run equilibrium when the farmer has full information about the technology and its potential (Feder et al. 1985). Adoption and diffusion are interrelated though different, in the sense adoption is when an individual makes use of an innovation, while diffusion means the spread of the innovation among a community or even globally (Feder et al. 1985). Adoption of SRI practices has several benefits: More vigorous growth of the paddy plant; Quantity of the harvest is higher; Cost of inputs is lower; Amount of labor needed is higher; Quality of the harvest is higher; Weed control is easier than expected; Water required for irrigation is less and amount of seeds needed is lower.

2.5.1 Spatial and temporal dynamics

The spatial and temporal dynamics includes the intensity and incidence. Intensity refers to the extent of use of an innovation by the adopting unit once the adoption decision has been made (Doss, 2003). Adoption is a continuous measure. In this case, it is the percentage of rice area under SRI. In this study, adoption of SRI can be described as the innovation-decision process as described in Evans (1988) and Rogers (1995), where farmers went through a stage of being aware of the SRI methodology, formed either positive or negative attitude towards SRI and finally decided to or not to adopt the SRI. It refers to the proportion of farmersôtotal fields allotted to SRI practice. Incidence on the other hand means the adopting unit has used or not used the innovation during a reference time (Doss, 2003). Adoption is discrete with binary variables where a farmer may be an adaptor but still use the old innovation on part of his/her farm. SRI adopters are those farmers who tried SRI at least once during the last 5 years. They also include those who say they have tried SRI and what they practice under system of SRI varies widely from farm to farm. SRI adopters hence include partial adopters and those who have tried SRI and then abandoned it or discontinued practicing it. Non-adopters refer to those who have not practiced SRI (Doss 2003). In this case, SRI adopters/ farmers are those farmers who tried SRI at least once during the last 5 years (2009-2014)

2.5.2 Benefits of System of rice intensification (SRI) as compared to the normal practices

Some of the benefits of System of rice intensification (SRI) as compared to the normal practices are: It helps the farmers to improve their livelihood where itsô performance has raised hope among policy makers, development activists and farmers to solve the food deficit problem in remote areas where modern technologies are not feasible in terms of cost and accessibility. Tech (2004); It helps to increase the yields and production while reducing farmersô costs of production, and decreases the water requirement for irrigation up to 50 percent less (Randriamiharisoa et al. 2006; Stoop et al. 2002; Uphoff 2007 a); It helps resource-poor farmers to attain higher yields despite having infertile soil, no mineral fertilizer input, reduced irrigation and fewer seeds (Stoop et al.2002); SRI plants have large and strong root systems which enable them to tolerate adverse climatic influences as water stress, drought, storm damage, cold snaps and heat waves; It offers 15 percent more of milled rice (kg of consumable rice per bushel of paddy) since has less chaff (fewer unfilled grains) and less shattering (fewer broken grains) (Uphoff, 2007); More nutritional value and grain quality since SRI roots are larger and go deeper into soil thus up taking higher micronutrients from the soil.

2.6 Farmers perception of system of rice intensification and rice production

Farmers who have experimented with SRI around the world relate many success stories, with reported increases in paddy yield ranging from 50-100%. There are possibilities of higher yields with less costly inputs and better tasting rice that is also healthier for the consumer

2.6.1 Rice yield

SRI is claimed to be a high yielding and environmentally friendly technology that relies on changing farmersô agronomic practices towards a more efficient use of natural resources (Uphoff and Randriamiharisoa, 2002). SRI can raise irrigated rice yields to about double the present world average without relying on external inputs also offering environmental and equity benefits (Uphoff, 2007)

2.6.2 Environmentally friendly

In the absence of free oxygen, methanogenic bacteria metabolize to produce methane (Neue, 1993). In flooded paddy soil, methane is produced largely by transmethylation of acetic acid and by reduction of CO_2 (Takai, 1970). There are higher emission rates of methane in non-SRI soil as compared to SRI soil. Oxidation of methane is done by methane-oxidizing bacteria called methanotrophs which is found in oxidized floodwater soil (Neue, 1993). Aerating the soil through intermittent flooding enhances methane oxidation and therefore decreases methane formation (Neue, 1993. Low emission of methane from SRI soil may also be attributed to its low fertilizer use and more use of compost. Organic amendments and nitrification inhibitors increase methane oxidation potential whereas fertilizer N inhibits the CH_4 oxidation process (Adhya et al. 2000). Compost is one of the best measures to mitigate CH_4 emission (Kumaraswamy et al. 2000).

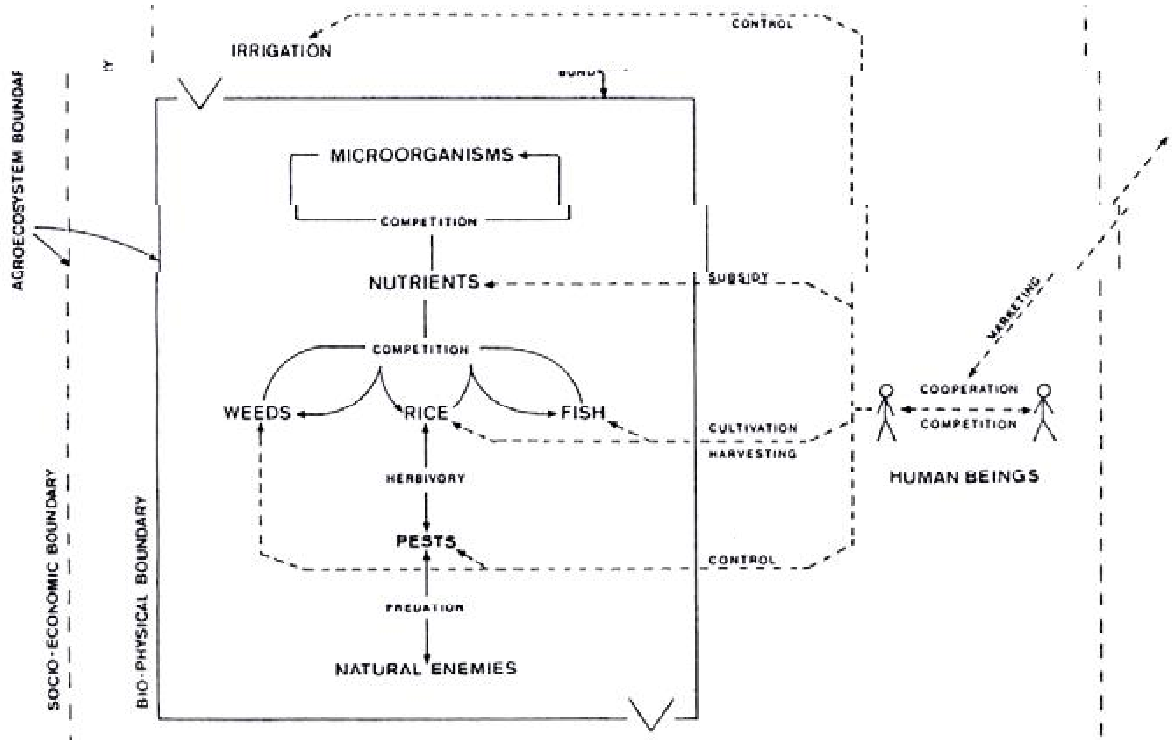
Additionally, Climate change has been a global issue nowadays which is attributed to green house gases emission from agriculture (Wassmann et. al. 2004). Flooded rice field releases large quantities of CH_4 (Bronson et al. 1997; Wassmann et. al.2004). Applications of N-fertilizers on such fields assist releasing N_2O, a climate gas (Wassmann et. al. 2004). Increased use of chemical fertilizers with N-content increases release of more N_2O gas from rice field decreasing net CH_4 uptake by soil.

2.6.3 Inputs

SRI is considered suitable for resource poor producers since does not depend on additional external inputs (Africare et al., 2010). It is usually understood as a package of possible practices, which have to be adapted to local conditions (Glover, 2011; McDonald et al., 2006; Stoop, 2011). Farmersô perception of relative yield variance affects the allocation of inputs (Smale, 1995)

2.7 Theoretical Framework

This study is based on Agro-ecological management theory which requires applying different practices to crops and conditions, rather than applying a fixed set of practices. Agro-ecosystems approach focuses on the connection between the biological and the social-technical dimension of the farm (Conway, 1996). It is a hierarchy of systems, where each level is to be studied on its own right and in relation to the other levels above and below. Agro-ecological approach to crop production is guided by management of interactions between genetic potential and environmental conditions, unlike technological management which assumes that the most determining factors are genetic (Panabokke, 1996).



Source: Conway 1987

Fig 1: Rice field as an agro-ecosystem

Rice field in an agro-ecosystem indicates that a farmer is not just an observer of the system but a part of the system and the cropping system cannot be fully studied and understood without taking into account the values and the logics that the processes are organized around. Figure 1 above shows that the farmer is responsible for controlling irrigation, pests and diseases, responsible for adding nutrients to the rice field, cultivation and harvesting. Weeds and micro-organisms compete with the rice plant for the nutrients. Pests, predators and herbivores are natural enemies to the rice produce. This study therefore sought to determine how rice management practices, farmersô awareness, perception and adoption of SRI influence rice production.

2.8 Conceptual Framework

According to Reichel and Ramey (1987) a conceptual framework is a set of broad ideas and principles taken from relevant fields of enquiry and used to structure a subsequent presentation. It is a research tool intended to assist a researcher in developing and understanding of the situation under investigation. The proposed study will utilize conceptual framework to show relationship of various variables on rice production under SRI.

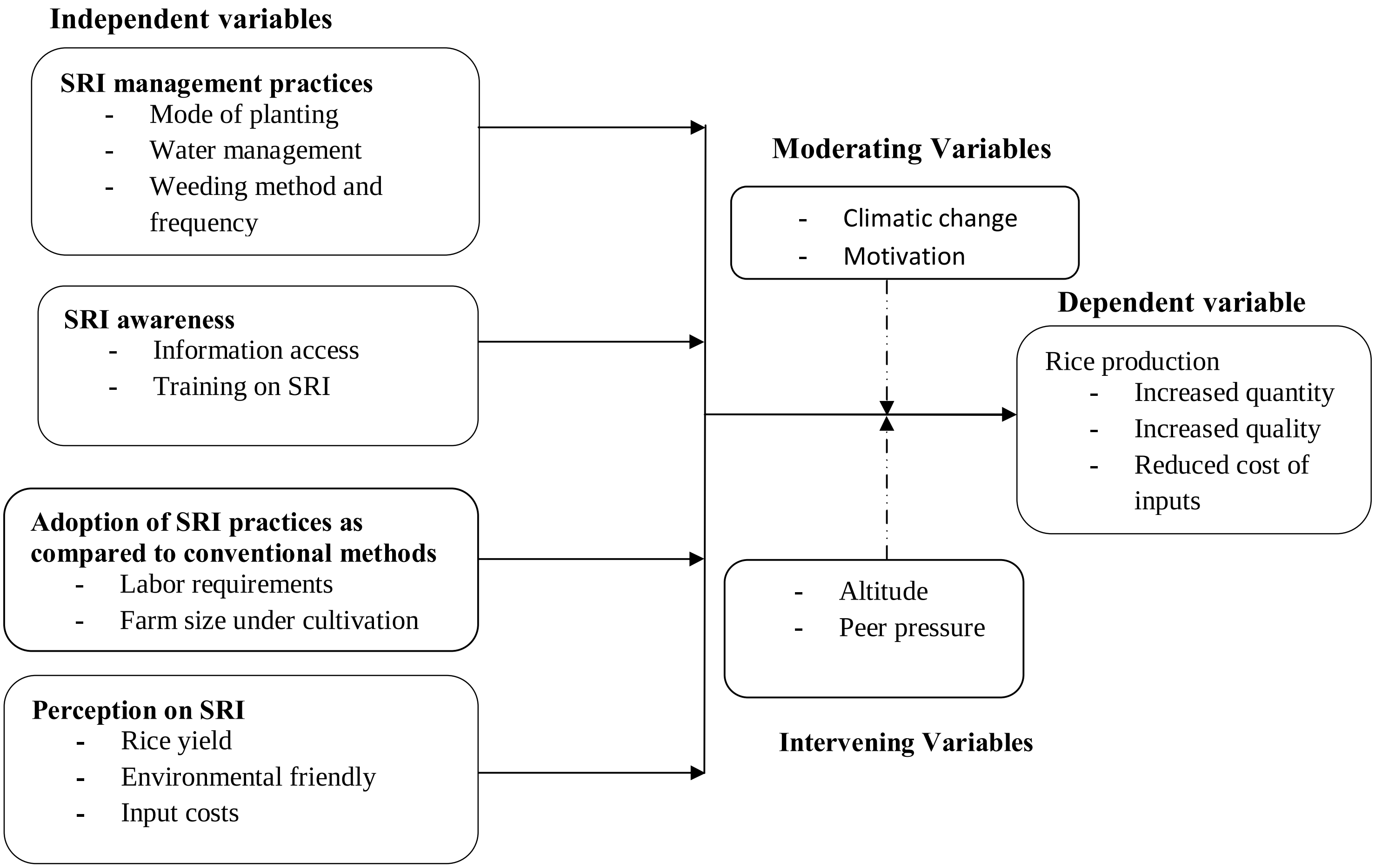


Fig 2: Conceptual frame work

An independent/ predictor variable is one that is presumed to affect or determine a dependent variable. Independent variables cause changes in the dependent variable. A dependent variable is a variable whose outcome depends on the manipulation of the independent variable. Intervening variable is that which might affect the relationship between the dependent and independent variable but difficult to measure or to see their nature of their influence. Moderating variable on the other hand behaves like the independent variable in that it has a significant contribution to the relationship between the dependent and independent variable (Mugenda and Mugenda, 2003). In this study, the dependent variable rice production will depend on the independent variables which are SRI management practices; SRI awareness; perception of SRI; and adoption of SRI management practices as compared to the conventional practices. The intervening variables will be workersô motivation, altitude and peer pressure and the moderating variable will be climatic change.

2.9 Summary of Literature Review

The literature reviewed in this study clearly explains that rice production is a global issue which needs the application of certain management practices like changing how soil, water, nutrients and rice plants are managed to allow better growing conditions. The gap between consumption and production as well as between imports and consumption ratio has been increasing over the years with increasing population. This chapter also looked at each of the four independent variables and how they influence rice production.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research methodology that was followed in conducting the study. It sets out various stages and phases that were followed in undertaking the study and includes method of collection, measurement and analysis of data. It is organized under the following sub sections: research design, target population, sampling design, methods of data collection, operationalization of variables and data analysis.

3.2 Research Design

This study used descriptive survey research whereby it obtained information that described existing phenomena by asking respondents about their perceptions, attitude, behavior or values. The descriptive approach allowed the findings of the study to be presented through simple statistics, tables, mean scores, percentages and frequency distributions, (Mugenda and Mugenda, 2003). The study described the practices, challenges and suggestions regarding the influence of the system of rice intensification on rice production among the small scale farmers in Mwea Constituency Kirinyaga County. The main focus of this study was quantitative. However, some qualitative approaches were used.

3.3 Target Population

The target population in this study was Tebere ward in Mwea constituency situated in Kirinyaga County. Mwea Constituency has a population of 190,512 with 55,841 households and a population density of 351.1 people per km2. Tebere has the largest population (31,645) amongst all wards comprising of 9,275 (table 3.1) households hence a true representation of the rice farmers in Mwea constituency [independent Electro and Boundaries Commission (IEBC)]. Mwea irrigation scheme covers a total of 24,000 hectares where the farmers mostly grow Pishori aromatic rice through irrigation with direct water from river Nyamindi and river Thiba (National Irrigation Board data).

The target population in this study referred to 9,275 households which sought to study the influence of the system of rice intensification on rice production among the small scale rice farmers. Some of the characteristics observable in this target population were: small scale rice farming under irrigation and use of System of rice intensification and/or conventional methods in rice farming to which the researcher generalized the results of the study.

Table 3.1: The eight wards of Mwea irrigation scheme and their respective population size.

NO.	Name	Population	Households	Description (Sub–Locations of Kirinyaga County)
1	Mutithi	26,864	7874	Rukanga, Kabiriri, Kiandegwa
2	Kangai	19,300	5657	Kombuini, Mathigaini and Kathiga
3	Thiba	23,219	6806	Nguka and Thiba
4	Wamumu	17,881	5241	Wamumu Subï Location of Kirinyaga County
5	Nyangati	25,016	7333	Kamiigwa, Kangu, Kirimara, Kithiriti and Nyangati
6	Murinduko	28,250	8280	Kamunyange, Mugamba-Ciura, Miuu and Riagicheru
7	Gathigiriri	18,337	5375	Mathangauta, Gathigiriri and Mahiga-Ini
8	Tebere	31,645	9275	Kiarukungu Subï Location of Kirinyaga County
	Total	**190,512**	**55,841**	

Source: Independent Electoral and Boundaries Commission (IEBC) 2009 National census.

3.4. Sampling Size and Procedure

A sampling frame of 9,275 households described the list of all population from which the sample of 368 was selected as described by (Cooper and Schindler, 2003). This study used two stage-cluster sampling to select the sample. In this technique, the random sampling was conducted such that the entire population was divided into groups or clusters as previously described by Mugenda and Mugenda (2003).

The study used Krejcie and Morgan table/formula to come up with a sample size of 368 households. Two stage cluster random sampling was then done whereby the 368 households were divided by the four villages in Tebere ward (Mathangauta, Murubara, Mahigaini and Kirogo) to arrive at 92 households for each village. The 92 households were randomly selected from each village.

Krejcie and Morgan formula:

$$S = \frac{X^2NP\,(1-P)}{d^2\,(N-1) + X^2P\,(1-P)}$$

where:

S = required sample size.
X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841).
N = the population size.
P = the population proportion (assumed to be .50 since this would provide the maximum sample size).
d = the degree of accuracy expressed as a proportion (.05).

Hence,

$$S = \frac{3.841 * 9275 * 0.50\,(1-0.50)}{0.05^2\,(9275-1) + 3.841 * 0.50(1-0.50)}$$

= 368

3.5 Data Collection Instruments

The study used both primary and secondary data. Primary data was obtained through self-administered questionnaires. Closed ended questions enabled the study to collect quantitative data while the open ended questions collected qualitative data.

The questionnaire was divided into five sections. Section (I) was concerned with biography information about respondent while section (II) captured the awareness of SRI, section (III) captured the SRI management practices, section (IV) captured the adoption of SRI and section (V) captured the perception of SRI variables among the small scale farmers in Mwea. The method of administering the questionnaire was by use of research assistants. The respondents were presented with a series of statements and asked to indicate their degree of agreement or disagreement (Likert Scale)

3.5.1 Validity of the Research Instrument

Validation of the research instrument was done by use of a pilot study. Prior to the actual study, pilot test of the measures were conducted against prospective sample population in order to measure validity as described by Mugenda and Mugenda, 2003. The questions were reexamined and ensured that they were not ambiguous, confusing, or potentially offensive to the respondents leading to biased responses. The wording of items was carefully modified based on the pilot test outcomes and reviewed. After administering the instrument to the selected respondents, the data obtained was a true reflection of the variables under study. The subject approached during piloting was marked to avoid them being applied in the final study. The feedback was used to validate the instrument for the study. The research assistants administered the questionnaires to the respondents.

3.5.2 Reliability of the Research Instrument

To test the reliability of the instrument, the researcher used the split-half technique. The instrument was split into two sub sets (the sets which have odd numbers and even numbers). All even numbered items and odd numbered responses in the pilot study were computed separately. By using this method, the researcher aimed at determining the co-efficient of internal consistency and the reliability co-efficient whose value varied between 0.00 (indicating no reliability) and +1.00 (indicating perfect reliability). The odd numbered scores for all items were correlated with even numbered scores using Spearman Brown Prophecy formula. The instrument met the aspects of stability and equivalency as described by Mugenda and Mugenda, 2003.

Spearman Brown Prophecy formula:

Reliability of scores on total test = $\frac{2 \times \text{reliability for } \frac{1}{2} \text{ test}}{1 + \text{reliability for } 1/2 \text{ test}}$

Table 3.2 Operationalization of Variables

Objective	Variables	Indicator	Level of measurement	Research design	Data collection method	Data analysis
Independent Establish the rice management practices among the farmers and how they influence rice production	SRI management practices	-Mode of planting -Water management practice -Weeding method -Type of manure	Ordinal	-Qualitative -Quantitative	-Survey -Document review	Descriptive
Investigate how farmers awareness of System of rice Intensification influences rice production	SRI awareness	-Training and extension -SRI awareness and implementation -Information access	Ordinal	-Qualitative -Quantitative	-Document review -Survey	Descriptive
Determine how the adoption of System of rice Intensification as compared to normal practices influences rice production	Adoption of SRI practices as compared to convectional practices	- Owned and rented farm size -Farm size under cultivation -Rice yields after SRI -Source of labor and labor-gender distribution	Ordinal	-Qualitative -Quantitative	-Document review -Survey	Descriptive
Access how farmersô perception of System of rice Intensification influences rice production	Perception on SRI	Rice yields Input costs	Ordinal	-Qualitative -Quantitative	-Document review -Survey	Descriptive
Dependent Influence of rice intensification system on rice production among small scale rice farmers. Case of Tebere, Mwea in Kirinyaga county	Rice production	-Rice quantity -Rice quality -Cost of inputs	Ordinal	-Quantitative	Document review Survey	Descriptive

3.6 Data Analysis

The primary data was analyzed through the use of descriptive statistics such as the mean, standard deviation and frequency distribution. The quantitative data was analyzed using Statistical Package for Social Science (SPSS). Frequency tables were used for general information.

3.7 Ethical Considerations

Ethical issues touch on deception and invasion of privacy. The research observed the ethical issues by: maintaining utmost confidentiality about the respondent; treating all people with respect and courtesy including those not autonomous like small children, aged and mentally retarded; ensuring that the procedures are reasonable, non-exploitative and carefully administered; competent researcher and research assistants; voluntary, informed and agreed participation of the respondents without threats or inducements and the respondents were informed of non compensation for their participation. The information volunteered by the respondents was not used for any other purposes other than for drawing the conclusion of the study. The researcher ensured that necessary research authorities were consulted, permission granted and due explanations given to the respondents before commencement of the study.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

The purpose of this chapter is to present, analyze and interpret the data in order to answer the research questions. The data was collected through questionnaire as the main data collection instrument while secondary data was used to collaborate the views of the respondent. To enhance quality of data obtained, likert type questions were included whereby respondents indicated the extent to which the variables were practiced in a five point likerts scale. The purpose of data analysis was to determine the influence of rice intensification system on rice production among small scale rice farmers based on the views of the respondents.

4.2 Response Rate

The study targeted 368 respondents. Out of these, 354 questionnaires were filled-in and returned making a response rate of 96.20%. This was a commendable response rate which was made a reality by research assistantsô effort to visit the respondents.

4.3 Gender Distribution

Table 4.1: Gender of Respondents

Response	Frequency	Percentage
Male	232	65.5
female	122	34.5
Total	**354**	**100**

Majority of the respondents (65.5%) were male while 34.5% were female as shown in table 4.1. This implies that composition guarantee the study wide response across the gender divide.

4.4 Level of Education

Table 4.2: Level of Education

Education level	Frequency	Percentage
Primary	146	41.2
Secondary	185	52.3
Diploma/ Certificate	15	4.2
Bachelor	8	2.3
Total	**354**	**100**

The study requested the respondents to indicate their education level. Table 4.4 below presents their responses whereby majority had secondary school education as shown by 52.3%, 41.2% were primary school leavers, 4.2% had diploma while 2.3% had first degree.

4.5 Rice Management Practices and Rice Production

The first objective of the study established the rice management practices among the respondents and their influence on rice production. The variables used were: mode of planting; water management practices; weeding method and interval, and type of manure.

4.5.1 Mode of planting

Table 4.3: Method of planting

Planting Method	Frequency	Percentage %
Transplanting	354	100
Broadcasting	0	0
Total	**354**	**100**

The respondents were asked which mode of planting they used. Table 4.3 presents method of planting. From the findings, 100% of the respondents transplanted their seedlings and none used broadcasting method.

Table 4.4: Seedlings per hill

Seedlings per hill	Frequency	Percentage
1-2 seedlings	254	71.8
2-3 seedlings	38	10.7
>3 seedlings	62	17.5
Total	**354**	**100**

The study asked the respondents how many seedlings they transplanted per hill. Table 4.4 above presents their responses on seedlings per hill. Majority of the respondents, 71.8% planted 1-2 seedlings, 17.5% planted more than 3 seedlings and 10.7% planted 2-3 seedlings per hill.

Table 4.5: Age of the seedlings when transplanting

Age	Frequency	Percentage
< 15 days	262	74
>15 days	92	26
Total	**354**	**100**

The respondents were asked about the age of the seedlings when transplanting. Table 4.5 above presents their responses. Majority of them, 74%, transplanted the seedlings when 15 days old and below while 26% transplanted seedlings older than 15 days old.

Table 4.6: Planting Distance

Planting Distance	Frequency	Percentage
< 15 x 15 cm	77	21.8
>15x 15 cm	277	78.2
Total	**354**	**100**

The study asked the respondents their planting distance. Table 4.6 presents their responses. Majority of the respondents planted the seedlings at an interval of more than 15x15 as shown by 78.2% as compared to 21.8% of the respondents who planted the seedlings at an interval less than 15x15 cm.

Table 4.7: Planting arrangement

Planting Arrangement	Frequency	Percentage
In rows	323	91.2
Random	31	8.8
Total	**354**	**100**

The respondents were asked to indicate their planting arrangement. Table 4.7 presents their responses. Majority of the respondents, 91.2%, planted the seedlings in rows while 8.8% planted in random.

Table 4.8: Duration between uprooting and transplanting

Transplanting Duration	Frequency	Percentage
Minutes	285	80.5
Hours	69	19.5
Days	0	0
Total	**354**	**100**

The study requested the respondents to indicate the time they took between uprooting and transplanting the seedlings. Table 4.8 above presents their responses. Majority of the respondents took minutes to transplant the seedlings after uprooting as shown by 80.5% as compared to 19.5% of the respondents who took hours to transplant after uprooting.

4.5.2 Water Management

Table 4.9: Level of water during Transplanting

Water Level	Frequency	Percentage
Flooded	31	8.8
Just moist	323	91.2
Total	**354**	**100**

The respondents were asked to indicate their water management practices during transplanting. Table 4.9 above presents their responses. Majority of them transplanted the seedlings to a just moist land as shown by 91.2% as compared to 8.8% of the respondents who transplanted in a flooded land.

Table 4.10: Water management during vegetative stage

Water Management	Frequency	Percentage
Permanently flooded	38	10.7
Alternate flooding and drying	316	89.3
Total	**354**	**100**

The study asked the respondents of their water management during the vegetative stage. Table 4.10 presents their responses. Majority of the respondents, 89.3%, alternated flooding and drying while 10.7% permanently flooded the land during the vegetative stage.

4.5.3 Weeding Method and Interval

Table 4.11: When the respondents weed

When do you weed	Percentage
When weeds appear	39.0
One month after planting	17.1
Depends with land condition	4.9
After one &half months	12.2
After three weeks	7.3
After two weeks	19.5
Total	**100.0**

The study asked the respondents about their weeding timings. Table 4.11 above shows the responses on when they weeded. Majority of the respondents indicated that they weeded when weeds appeared as shown by 39%, 19.5% weeded after two weeks, 17.1% weeded one month after planting,12.2% after one and half months, 7.3% after three weeks and 4.9% indicated it depended with the land condition.

Table 4.12: How the respondents weed

How do you weed	Percentage
Use of herbicides	29.3
Use push weeder	29.3
Done manually by hands	41.5
Total	**100.0**

The respondents were asked how they weeded. Table 4.12 above presents their responses. Majority of the respondents weeded manually by hand as shown by 41.5% while 29.3% used herbicides and 29.3% used push weeder.

4.5.4 Type of Manure

Table 4.13: How the respondents fertilize the rice crops

Material used for soil fertility	Percentage
Compost manure application	19.6
Fertilizer application	80.4
Total	**100.0**

The respondents were asked how they fertilize their rice crops. Table 4.13 presents the responses on rice crop fertilization. The table shows that 80.4% broadcasted fertilizers into the rice crop while 19.6% used compost manure.

Table 4.14: Availability of animals for manure production

Animals Availability	Frequency	Percentage
YES	231	65.3
NO	123	34.7
Total	**354**	**100**

The respondents were requested to indicate if they had animals for manure production. Table 4.14 shows 65.3% of the respondents had animals for manure production whereas 34.7% did not have animals for manure production.

Table 4.15: Rice straw

What happens to rice straw	Frequency	Percentage
Left in the field	8	2.3
Removed & used for compost	92	26
Burned in the field	39	11
Removed and never utilized	-	-
Others	215	60.7
Total	**354**	**100**

The study asked the respondents what happened to the rice straw. Table 4.15 shows majority of the respondents had other uses for the rice straw like selling and as food for the animals as shown by 60.7%, 26% used it for compost, 11% burned it in the field and 2.3% left it in the field.

4.5.6 Pesticides/ Herbicides

Table 4.16: Pesticides/ Herbicides usage

Pesticides/Herbicides usage	Frequency	Percentage
YES	354	100
NO	0	0
Total	**354**	**100**

The study asked the respondents of their pesticides or herbicides usage. Table 4.16 shows that all the respondents used pesticides or herbicides.

4.6 Farmers Awareness on System of rice Intensification and Rice Production

The second objective of the study sought to investigate if the awareness on system of rice intensification (SRI) influences rice production. The indicators used were SRI training and extension, SRI awareness and implementation and information access.

4.6.1 SRI Training and Extension

Table 4.17: SRI Training and Extension

Response	**Frequency**	**Percentage %**
Yes	**269**	**76**
No	**85**	**24**
Total	**354**	**100**

The respondents were asked whether they have ever attended any SRI training Table 4.9 below presents the responses on SRI training and extension. Majority of respondents had attended SRI training as shown by 76% as compared to 24% of the respondents who had never attended any SRI training.

Table 4.18: Satisfaction of SRI training

Response	Frequency	Percentage
Very satisfied	9	3
satisfied	260	97
indifferent	-	-
unsatisfied	-	-
very unsatisfied	-	-
Total	**269**	**100.0**

The study asked the respondents about their level of satisfaction with the training. Table 4.18 above presents their responses whereby majorities, 97%, were satisfied with the training while 3% were very satisfied. None of the respondents who had attended SRI training were unsatisfied or indifferent with the training.

4.6.2 SRI Awareness and Implementation

Table 4.19: SRI awareness and Implementation

Indicators	Implemented	Mean	Std dev
Reduced rice seed	307	25.58	84.85
Seed bed preparation	307	25.58	84.85
Flat rice field/ leveling	292	24.33	80.7
Select only vigorous seedlings for transplanting	269	22.42	74.35
Transplanting young seedlings <15days	307	25.58	84.85
Short time gap between careful uprooting and same day transplanting	300	25	82.92
Planting in rows	315	26.25	87.06
Wider spacing (25-50cm)	223	18.58	61.63
Shallow planting	261	21.75	72.14
Flood &dry the field for alternative periods	177	14.75	48.92
Early &frequent weeding	307	25.58	84.85
Add nutrients to the soil, preferably in organic form. Reduce chemical fertilizer inputs	261	21.75	72.14

The study tested the respondentsô SRI awareness and implementation using various indicators. Table 4.19 above presents their responses. Out of the 85 respondents who had indicated that they had never attended any SRI training, 46 respondents said that they had learnt of the SRI through observation from other neighboring farmers.

4.6.3 SRI Information Access

Table 4.20: Farmer's Association

Membership	Frequency	Percentage
Member of any farmers association	316	89.3
Non Member of any farmersô association	38	10.7
Total	**354**	**100**

The respondents were asked if they belonged to any farmersô association. Table 4.20 above presents their responses. According to the findings, majority of respondents belonged to a farmersô association as shown by 89.3% as compared to 10.7% of the respondents who werenöt members of any farmersô association.

4.7 Adoption of Rice Intensification as compared to normal practices and Rice Production

The third objective of the study sought to determine how the adoption of system of rice intensification influences rice production. The indicators used were: farm size owned; rented farm size; farm size under SRI cultivation; length of SRI practice and gender labor distribution.

4.7.1 Owned and Rented Farm Size

Table 4.21: Total farm size owned

Farm Size (Acres)	Frequency	Percentage
< 2 acres	239	67.5
>2 acres	115	32.5
Total	**354**	**100**

Respondents were asked of their total farm size owned. Table 4.21 above presents the total farm size owned. Majority of the respondents owned less than 2 acres of land as shown by 67.5% and 32.5% owned more than 2 acres.

Table 4.22: Rented additional land

Response (Yes/No)	Frequency	Percentage
YES	92	26
NO	262	74
Total	**354**	**100**

The study requested the respondents to indicate if they rented any additional farm size. Table 4.22 above shows that majority of the respondents, 74%, did not rent additional land for farming as compared to 26% of the respondents who rented additional land for farming.

4.7.2 Farm size under rice cultivation

Table 4.23: Farm size under rice cultivation

Farm Size	Frequency	Percentage
0.5 ha	31	8.8
1 ha	169	47.7
1.5ha	38	10.7
2 ha	69	19.5
2.5ha	8	2.3
3ha	23	6.5
4 ha	16	4.5
Total	**354**	**100**

The study asked the respondents their farm size under rice cultivation, Table 4.23 shows that majority of the respondents had 1ha of land under rice cultivation as shown by 47.7%, 19.5% for 2ha, 10.7% for 1.5ha, 8.8% for 0.5ha, 6.5% for 3ha, 4.5% for 4ha and 2.3% for 2.5ha.

4.7.3 Rice Yields after SRI

Table 4.24: Rice yields (Kgs) before and after applying SRI

Rice Farming Method	Mean	Std dev
Normal	2,228.84	54.11
SRI	3,050.41	74.36

The study asked the respondents to indicate their rice yields before and after SRI. Table 4.24 presents the mean and standard deviations of the rice yields under normal practices and under SRI. System of rice intensification (SRI) had a higher mean score than the normal practices of rice farming as shown by 3,050.41 for SRI and 2,228.84 for normal practices

4.7.4 SRI Practice

Table 4.25: Length of Time Practicing SRI

Practice duration	Frequency	Percentage %
Less than 3yrs	123	34.7%
3-5 years	177	50%
Not practicing SRI	54	15.3%
Total	**354**	**100**

The study asked the respondents about their SRI practice. Table 4.25 shows 50% of the respondents had been practicing SRI between 3-5years, 34.7% for less than 3years while 15.3% had never practiced SRI.

4.7.5 Source of labor and gender labor distribution

Table 4.26: Main source of Labor for rice production

Source of Labor	Frequency	Percentage
Family labor	23	6.5
Hired	331	93.5
Total	**354**	**100**

The respondents were asked about their main source of labor. Table 4.26 presents their responses. Majority of the respondents hired labor for rice production as shown by 93.5% as compared to 6.5% of the respondents who used family labo

4.7.6 Gender Labor Distribution

Table 4.27: Gender labor distribution in rice cultivation (SRI areas)

Activity	Female	Male	Children	Female%	Male%	Children%
Ploughing	3	351	0	0.8	99.2	-
Leveling	7	347	0	2.0	98.0	-
Establish drainage channel	0	354	0	-	00.0	-
Sowing seeds in nursery	82	272	0	23.2	76.8	-
Transplanting	219	11	124	61.9	3.1	35.0
Weeding	256	79	19	72.3	2.3	5.4
Application of fertilizer/manure	5	346	3	1.4	97.7	0.8
Compost preparation	8	346	0	2.3	97.7	-
Water management	15	334	5	4.2	94.4	1.4
Application of pesticides/pest control	5	346	3	1.4	97.7	0.8
Harvesting	105	240	9	29.7	67.8	2.5
Threshing	223	103	28	63.0	29.1	7.9
Transport	8	346	0	2.3	97.7	-

The study presented several activities in rice production to the respondents and asked them to indicate the gender that carried out the activity. Table 4.27 presents their responses. The table shows that almost all of the rice cultivation activities are done majorly by men except transplanting and threshing which is mainly done by women and children.

4.8 Farmers' Perception of System of Rice Intensification and rice production

The fourth objective of the study aimed at accessing how the respondentsô perception of SRI influences rice production. The main indicators used were: rice yields and input costs

Table 4.28: Perception of SRI on various indicators

Activity	Agree	Mean	Std
Increases rice yields	323	24.8	86.1
Requires less seeds for planting	323	24.8	86.1
Requires less external inputs (mineral fertilizer, pesticides, herbicides)	138	10.6	36.8
Requires more labor	54	4.2	14.4
Increases weed problems	62	4.8	16.5
Increases the pressure of pests and diseases	23	1.8	6.1
Increases the risk of crop failure due to flooding/drought	85	6.5	22.6
Transplanting one/two young seedlings bears more risk of crop failure	131	10.1	34.9
Uprooting and transplanting seedlings without delay is feasible for me	208	16.0	55.4
I can easily manage to plant seedlings in rows	308	23.7	82.1
Water management under SRI is feasible for me	246	18.9	65.6
The soil quality improves when applying SRI	162	12.5	43.2
Time requirement for compost making is feasible for me	185	14.2	49.3
Enough animal manure &compost available to fertilize the rice crop	200	15.4	53.3
SRI has increased my self sufficiency in rice	323	24.8	86.1
SRI also suitable for poor farmers	246	18.9	65.6

The study tested the respondents SRI perception by requesting them to indicate their level of agreement to the various indicators presented to them as shown in table 4.28 above. The table presents the mean and standard deviation on the various indicators used.

4.9 Cross Check on rice yield after SRI and overall SRI satisfaction

Table 4.29: Rice yield after SRI as compared to before SRI

Rice Yield after SRI	**Frequency**	**Percentage**
Much higher	169	52.3
A little Higher	154	47.7
Same as before	0	0
A little less	0	0
Much less	0	0
Total	**323**	**100**

The study conducted a cross check where the respondents were asked of their rice yield after using SRI as compared to before SRI. Table 4.29 shows 52.3% indicated that the rice yield was much higher after SRI and 47.7% indicated that the yield was a little higher after SRI. None of the respondents indicated as having same yield as before SRI or less after SRI.

Table 4.30: SRI satisfaction

Satisfied with SRI (Yes/No)	**Frequency**	**Percentage**
YES	315	97.5
NO	8	2.5
Total	**354**	**100**

The study also conducted a cross check on the respondents SRI overall satisfaction. Table 4.30 presents their responses. Majority of the respondents were satisfied with SRI as shown by 97.5% and 2.5% indicated they were not satisfied with SRI.

CHAPTER FIVE

SUMMARY OF THE FINDINGS, DISCUSSIONS, CONCLUSONS AND RECOMMEDATIONS

5.1 Introductions

This chapter provides the summary of the findings, discussions, conclusions, recommendations and suggestions for further research.

5.2 Summary of the Findings

This section summarizes the findings from chapter four. The summary is as per the objectives of the study.

5.2.1 Rice Management Practices

According to the findings, all the respondents transplanted all their seedlings and none used broadcasting method of planting. Majority of the respondents, 71.8% planted 1-2 seedlings per hill, 74% transplanted the seedlings at the age 15 days old and below at an interval of more than 15x15 (78.2%) and were planted in rows (91.2%). Majority of the respondents, 80.5%, indicated that they took minutes to transplant the seedlings after uprooting. Majority, 91.2%, transplanted the seedlings to a just moist land and 89.3% of the respondents alternated flooding and drying during the vegetative stage. Majority of the respondents, 39%, weeded when weeds appeared, 41.5% weeded manually by hand and 80.4% broadcasted fertilizers into the rice crop. Majority of the respondents (65.3%) had animals for manure production and 60.7% used rice straw for other uses like food for the animals and as a source of income. All the respondents used pesticides or herbicides.

5.2.2 Farmers' Awareness of system of rice intensification

Majority of respondents, 76%, had attended SRI training where 97% of them were satisfied with the training. None of them was unsatisfied/ indifferent with the training. There were recommendable mean scores and standard deviations in all the 13 indicators used to test SRI implementation. Majority of the respondents, 89.3%, belonged to a farmersô association.

5.2.3 How Adoption of the System of Rice Intensification Influences Rice production

Majority of the respondents (67.5%) owned less than 2 acres of land, 74% did not rent additional land for farming, 47.7% had 1ha of land under rice cultivation and 93.5% hired labor for rice production. System of rice intensification (SRI) had a higher mean score than the normal practices of rice farming as shown by 3,050.41 for SRI and 2,228.84 for normal practices. Majority of the respondents, 50%, had been practicing SRI between 3-5years. Almost all of the rice cultivation activities were done majorly by men except transplanting and threshing which was mainly done by women and children.

5.2.4 How Perception of the System of Rice Intensification Influences Rice Production

The 13 indicators used to measure the respondentsô perception of SRI showed recommendable mean scores and standard deviations. From the cross check, 52.3% of the respondents indicated that the rice yield was much higher after SRI and 97.5% of the respondents were satisfied with SRI.

5.3 Discussions

The first objective of the study was to establish the rice management practices among the farmers and how they influence rice production. All the respondents transplanted their seedlings and none used broadcasting method. Majority, 71.8%, transplanted 1-2 seedlings per hill, 74% transplanted 15days old and below seedlings, 78.2% transplanted the seedlings at an interval of more than 15 x15 cm and 91.2% transplanted the seedlings in rows. Majority of the respondents, 80.5%, took minutes to transplant the seedlings after uprooting. Under SRI, 8-15 day old single seedlings are planted with a minimum time interval between the time they are taken out from the nursery and planted carefully at grids of either 20 x 20 cm or 25 x 25 cm or 30 x 30 cm or even wider if the soil is very fertile (Gujja at al, 2013). Early planting, single planting and wider spacing has several benefits: extends the time for filleting, reduces transplanting shock, reduces competition for nutrients and increases photosynthesis (Sharif, 2009). Majority of the respondents, 91.2%, transplanted the seedlings into a just moist land and 89.3% alternated flooding and drying during the vegetative stage. The findings agreed with ATS, (1992) and Vallois, (1996) that the soil should occasionally be allowed to dry to the point of cracking thus allowing oxygen to enter the soil and also induce the roots to grow and "search" for water.

Majority of the respondents weeded when weeds appeared (39%), 41.5% weeded manually by hand and 80.4% broadcasted fertilizers into the rice crop. 65.3% of the respondents had animals for manure production, 60.7% used rice straw for other uses like food for the animals and as a source of income. As per Uphoff et al. (2009), the first weeding should be done 10-12 days after transplanting; organic manures, farm yard manure and vermin-compost are incorporated into the soil two weeks before planting; Compost can be made from any biomass (e.g. rice straw, plant trimmings and other plant material), some animal manure can be added if available as well as chemical fertilizers; Compost adds nutrients to the soil slowly and can also contribute to a better soil structure.

The second objective of the study was to establish how farmersô awareness of rice intensification influences rice production. According to the study, 76% of the respondents became aware of SRI through training, 13% through observing from fellow farmers and 97% of them were satisfied with the training. As per Joel (2011), there was good information flow and information sharing among agricultural stakeholders for better professional update and improved produce whereby 89.3% belonged to a farmersô association.. The mean scores and standard deviations of the various indicators used to test SRI implementation indicated majority of the respondents had implemented SRI. Implementation of SRI practices showed an increase in rice yield by an average of 432.21Kgs. This agrees with Fortin and Pierce (1998) that dissemination of adequate information literacy to the grass-root to the farmers enhances productivity.

The third objective of the study was to determine how the adoption of System of rice Intensification as compared to normal practices influences rice production. Majority of the respondents, 50%, indicated that they had been practicing SRI between 3-5years, 84.7% were SRI adopters which agrees with Doss (2003) that SRI adopters include partial adopters and those who have tried SRI and then abandoned or discontinued practicing it. Majority of the respondents, 93.5%, hired labor for rice production. This agreed with Uphoff (2007) that SRI increases labor requirements. Rice yields after SRI had a higher mean score of 3,050.41Kgs as compared to 2,228.84Kgs for normal practices. The findings agreed with Randriamiharisoa et al. (2006); Stoop et al. (2002) and Uphoff (2007) that SRI adoption increases the yields.

The fourth objective of the study was to access how farmersô perception of System of rice intensification influences rice production. The mean scores and standard deviations of the 13 indicators used to measure the respondentsô perception of SRI showed positive SRI perception among the respondents. The indicators measured on yields, seeds for planting, inputs, pests and diseases, crop failure and rice self sufficiency. From the cross check, 52.3% of the respondents indicated that the rice yield was much higher after SRI and 97.5% of the respondents were satisfied with SRI.

5.4 Conclusions

The study was a good representation of small scale rice farmers since majority of the respondents, 47.7%, had 1ha of land under rice cultivation. Good information flow among the agricultural stakeholders improved SRI awareness. The study concludes that farmersô awareness of system of rice intensification to a great extent influences rice production.

The study also concludes that the rice management practices among the farmers were mostly the SRI practices though some mixed the SRI practices with the conventional practices. For instance, majority of the respondents used chemical fertilizers in place of compost manure. This was mostly contributed by unavailability of animals for manure production. The management practices to a great extent influenced rice production whereby the SRI practices had higher yields.

The study found out that majority of the respondents (84.7%) were partial SRI adopters while the rest had either abandoned it or had never adopted it. The study concludes that the adoption of system of rice intensification greatly influences rice production.

The study also concludes that the respondents had a positive perception of SRI which greatly influenced rice production. System of rice intensification is perceived to increase yields, reduce seeds for planting, reduces external inputs since compost can be used in place of or together with fertilizers and easier management of pests and diseases.

5.5 Recommendations

The study recommends: i) There be good management of Mwea Multipurpose rice growers which will ensure the farmers get good quality seeds instead of the farmers having to recycle the seeds from their previous harvest; ii) Mwea Multipurpose rice growers and National Irrigation board to be more involved in empowering the farmers through training and finance to ensure 100% SRI adoption hence improve rice quality and yield.

5.6 Areas for Further Studies

The study focused on influence of rice intensification system on rice production among small scale rice farmers and established that farmersô awareness, rice management practices, adoption of system of rice intensification and farmersô perception of system of rice intensification influences rice production. In the course of work, I found that there is a major problem in: controlling the birds that compete for the harvest with the farmers and water management due to uneven land for rice cultivation; availability of farm inputs like machinery that would cut on labor. There is therefore need for further research on methods of controlling birds in rice fields to improve rice produce; further research on how to level the land for rice cultivation and further research on how the farmers can access cheap farm inputs like machinery.

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APPENDICES

APPENDIX I: INTRODUCTION LETTER

Date: é é é é é é é é ..

Dear Participant,

My name is Bancy Wambui Ndirangu and I am a postgraduate student at the University of Nairobi. For my final project, I am examining the influence of system of rice intensification on rice production among the small scale rice farmers with special reference to Tebere, Mwea Kirinyaga County. Because you are located in Tebere ward of Mwea constituency Kirinyaga County, I am inviting you to participate in this research study by completing the attached survey.

The following questionnaire will require approximately 20 minutes completing. There is no compensation for responding nor is there any known risk. Copies of the project will be provided to my University of Nairobi instructor. Please answer all questions as honestly as possible and return the completed questionnaire promptly. Participation is strictly voluntary.

Sincerely,

Bancy Wambui Ndirangu
+254 721 813 870
Wambui.bancy@gmail.com

Instructor:

Mr. James Kiige
+254 720 725021
jkiigem@yahoo.com

APPENDIX II: QUESTIONNAIRE

The information provided in this questionnaire will be treated with confidence and will be used only for academic purposes. Please fill in the questionnaire as accurately as possible.

Either tick in the appropriate box or answer in the space provided. If No to any of the questions, please proceed to the next question.

SECTION I: DEMOGRAPHIC INFORMATION

Enumeratoré ..
Dateé é é é é é é é é é é é é é é ..
Code No. é ..
1. Respondents Name é é é é é é é é é é é é é é é é .
Key farmer: Yes ☐ No ☐
2. Unit é é é é é é é é é é é é
3. Characteristics of the household:

Name	Sex	Age	Education	Involved in farming Yes/No

4. How much rice does your household / family need every month ____________Kg
5. Are you a member of any farmersô association? Yes ☐ No ☐
6. If yes specifyé é é é é é é é é é é é é é é é é
7. What is the total farm size you own? é é é é é é é é é é é é
8. Do you rent additional land? Yes ☐ No ☐
9. If yes, what is the size of the rented land? é é é é é é é é é é é
10. What is the Tenancy agreement? Per season☐ Per year☐ Other(specify) é é é é é é é é é
11. Do you hire casual labor? Yes☐ No☐
12. If yes, specify activity and duration

Activity	Man Hours/ Days

13. Sources of incomeé ..

SECTION II: HOW AWARENESS ON SYSTEM OF RICE INTENSIFICATION INFLUENCES RICE PRODUCTION

SRI Training and Extension:

1. Have you ever attended any SRI training? Yes ▢ No ▢

2. If yes, when? é é é é é é é é é é é Who was the facilitator? Farmer promoter/key farmer

3. How often do you attend the training? ....

4. How satisfied were you after the training?

Very satisfied	satisfied	indifferent	unsatisfied	Very unsatisfied

5. If unsatisfied, specify areas of un-satisfaction
é .

6. Which SRI practices do you remember and which of those did you implement?

Practice	Remembers Yes/No	Applied/ implemented Yes/No
Reduced rice seed		
Seed bed preparation		
Flat rice field/ leveling		
Select only vigorous seedlings for transplanting		
Transplanting young seedlings <15days		
Short time gap between careful uprooting and same day transplanting		
Planting in rows		
Wider spacing (25-50cm)		
Shallow planting		
Flood &dry the field for alternative periods		
Early &frequent weeding		
Add nutrients to the soil, preferably in organic form. Reduce chemical fertilizer inputs		

7. Did your extension worker/ program officer/farmer promoter visit you when you implemented SRI practices? Yes ▢ No ▢ If yes, how frequent per season? ....

8. Could the extension officer explain/ solve problems that you were facing by implementing SRI?

Yes all▢ Partly▢ No none of them▢

9. Which source of information was the most beneficial for you?

▢Training ▢Cross visit
▢ Individual visit by extension workers ▢Leaflet/ Magazine
▢ Farmer promoter/Key farmer ▢Field demonstration
▢ Individual from another farmer

10. Since when have you been practicing SRI? é é é é é é é é é é é é é é é é é ..

SECTION III: HOW SYSTEM OF RICE INTENSIFICATION MANAGEMENT PRACTICES INFLUENCES RICE PRODUCTION

1. Are you broadcasting the seeds or transplanting?
   Normal practice: Broadcasting ▢ Transplanting ▢
   SRI practice: Broadcasting ▢ Transplanting ▢
2. How much seed do you use in your practice?
   Normal practice é é é é é .Kg SRI practiceé é é é é é é é .Kg
3. How many seedlings per hill do you transplant?
   Normal practice é é é é é é SRI practiceé é é é é é é é .
4. How old are the seedlings when you transplant?
   Normal practice: é é é é é é days SRI practice: é é é é é days
5. How do you select the seedlings for transplanting?
   Normal practice é ..
   SRI practiceé ..
6. How deep do you plant the seedlings?
   Normal practice: é é é é é é cm SRI practice: é é é é é é é cm
7. What is the planting distance? é é é é é é é é é é é é é é ..
8. What is the planting arrangement?
   Normal practice: Random▢ In rows▢
   SRI practice: Random▢ In rows▢
9. How long does it take between uprooting young seedlings and transplanting?
   Minutes▢ Hours▢ Days▢
10. What is the water level during transplanting?
    Normal practice: Flooded▢ Just moist▢
    SRI practice: Flooded ▢ Just moist▢
11. How do you manage the water supply during the vegetative stage?
    Permanently flooded ▢ Alternative flooding &drying▢
12. When and how do you weed?
    é ..
    é ...
13. How do you fertilize your rice crop?
    é ..
    é

14. Do you have animals for manure production? Yes ▢ No ▢
    If yes, specify...

15. What are you doing with the rice straw?

Left in the field ☐ Removed and used for compost☐ Burned in the field ☐

Removed and never utilized☐

Others (specify)é .

16. Do you use pesticides/herbicides? Yes ☐ No ☐

If yes, specify é

SECTION IV: HOW ADOPTION OF THE SYSTEM OF RICE INTENSIFICATION INFLUENCES RICE PRODUCTION

1. Which is your main source of labor for rice production?

Family labor ☐ Hired ☐

2. Estimate your rice yields before and after applying SRI

Technology	Type of rice	Year	Area	Yield per area
Normal				
SRI				

3. What is the size of your farm under rice production? é é é é é é é ha
4. On how many hectares do you intend to use SRI the next season? é é é é ..ha
5. Self sufficiency on rice production

Before SRI: Surplus byé é é é é é Kg Just enough ☐ Not enough ☐

After SRI: Surplus byé é é é é é Kg Just enough ☐ Not enough ☐

6. Gender labor distribution in rice cultivation (SRI areas)

Activity	Female ✓	Male ✓	Children ✓
Ploughing			
Leveling			
Establish drainage channel			
Sowing seeds in nursery			
Transplanting			
Weeding			
Application of fertilizer/manure			
Compost preparation			
Water management			
Application of pesticides/pest control			
Harvesting			
Threshing			
Transport			

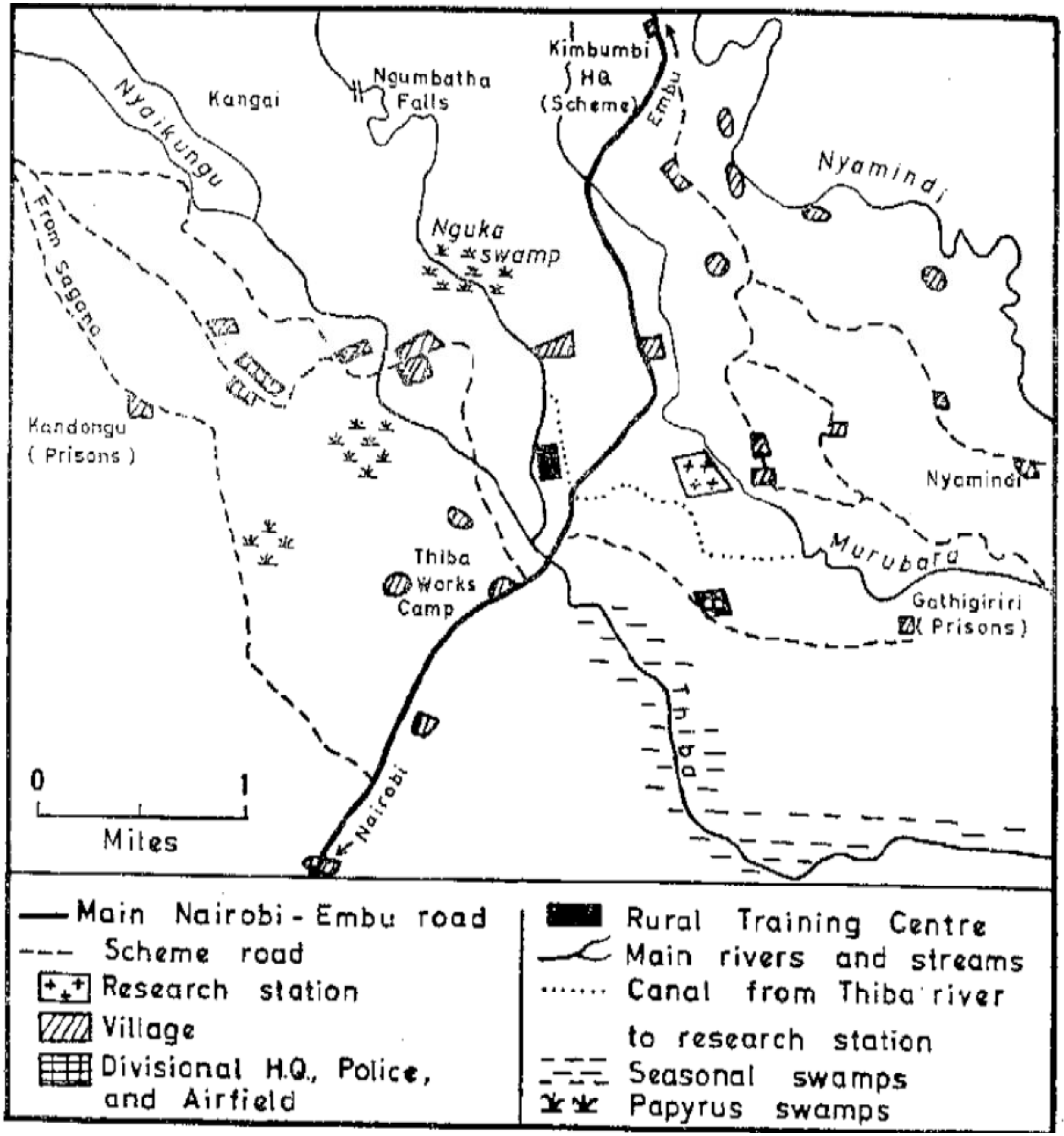
SECTION V: HOW PERCEPTION OF THE SYSTEM OF RICE INTENSIFICATION INFLUENCES RICE PRODUCTION

Activity	Disagree ✓	Indifferent ✓	Agree ✓
Increases rice yields			
Requires less seeds for planting			
Requires less external inputs (mineral fertilizer, pesticides, herbicides)			
Requires more labor			
Increases weed problems			
Increases the pressure of pests and diseases			
Increases the risk of crop failure due to flooding/drought			
Transplanting one/two young seedlings bears more risk of crop failure			
Uprooting and transplanting seedlings without delay is feasible for me			
I can easily manage to plant seedlings in rows			
Water management under SRI is feasible for me			
The soil quality improves when applying SRI			
Time requirement for compost making is feasible for me			
Enough animal manure &compost available to fertilize the rice crop			
SRI has increased my self sufficiency in rice			
SRI also suitable for poor farmers			

SECTION VI: CROSS CHECK QUESTIONS

1. How is your rice yield after using SRI components compared to before?
   Much higher ☐ A little higher ☐ Same as before ☐ A little less ☐ Much less ☐
2. Are you overall satisfied with SRI? Yes ☐ No ☐
3. Which are the major problems /difficulties in using SRI?
   é .
   é .
   é .

APPENDIX III: MAP OF TEBERE IRRIGATION SCHEME



APPENDIX IV: KREJCIE AND MORGAN TABLE

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size. *S* is sample size.

Source: Krejcie & Morgan, 1970