WORK RELATED INJURIES AND ILL-HEALTH AMONG FARM WORKERS AT SELECTED PUBLIC IRRIGATION SCHEMES IN KENYA

CHARLES MUIRURI MBURU

DOCTOR OF PHILOSOPHY

(Occupational Safety and Health)

JOMO KENYATTA UNIVERSITY OF

AGRICULTURE AND TECHNOLOGY

2019

Work Related Injuries and Ill-Health among Farm Workers at Selected Public Irrigation Schemes in Kenya

Charles Muiruri Mburu

A thesis submitted in fulfilment for the degree of Doctor of Philosophy in Occupational Safety and Health in the Jomo Kenyatta University of Agriculture and Technology

2019

DECLARATION

This thesis is my original work and has not been submitted for a degree in any other University.

Signature: ..... Date: .....

Charles Muiruri Mburu

This thesis has been submitted with our approval as University supervisors

Signature ……..Date…….

Prof. Robert Kinyua, PhD

JKUAT, Kenya

Signature ……Date……..

Prof. George Karani, PhD

Cardiff Metropolitan University, UK

Signature ……Date…….

Prof. Ciira Kiiyukia, PhD

Mt Kenya University, Kenya

DEDICATION

This research work has been dedicated to my mum, the late Peris Wambui Mburu who brought me up, encouraged and empowered me when I was young but did not live to see me complete my aspirations in education. I am who I am because of my mum.

ACKNOWLEDGEMENT

Special thanks go to my supervisors Prof Robert Kinyua, Prof George Karani and Prof Ciira Kiiyukia who were extremely helpful in providing invaluable guidance without which this study would not have been a success.

I sincerely thank the management of the National Irrigation Board for having provided an easy access to the irrigation schemes and specifically Mr Wanjala of Ahero, Mr Ibrahim Kimei of Perkerra and Chris Opondo of Mwea and for having given out the details of their schemes as requested and introduction to the irrigation water users association (IWUA).

I am greatly indebted to the officials of the irrigation water users association (IWUA) of the three irrigation schemes for having given more information about the scheme and also helping in the identification of the respondents. Without their assistance it would not have been easy to collect data from these schemes. Thanks too to all the respondents for sparing their time and all those we interacted with in the course of this research.

I wish to give my special thanks to my wife Cecilia for having had to bear with my absence sporadically. I know it was lonely at home without me and the children having established their homes but it was worth.

Finally and above all, I give glory to God for giving me the strength to face this challenging task and making it happen. Halleluiah.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

ABBREVIATIONS AND ACRONYMS

CDA	Coast Development Authority
CDC	Centre for disease control and prevention
DOSHS	Directorate of Occupational Safety and Health services
ENNDA	Ewaso Nyiro North Development Authority
ENSDA	Ewaso Nyiro South Development Authority
FAO	Food and Agriculture Organization
GOK	Government of Kenya
ILO	International Labour Organization
IUF	International Union of Food, Agricultural, Hotel, Restaurant, Catering, Tobacco and Allied Workers' Associations
KNBS	Kenya National Bureau of Statistics
KVDA	Kerio Valley Development Authority
LBDA	Lake Basin Development Authority
LWC	- Lost Workday Case
MM	Millimetres
MOA	Ministry of Agriculture, Kenya
MSDS	Material Safety Data Sheets
NIB	National Irrigation Board, Kenya

OELs	Occupational Exposure Limits
OSH	Occupational Safety and Health
OSHA	Occupational Safety and Health Administration, USA.
OSHA, 2007	Occupational safety and Health Act, 2007 – Kenya.
PCPB	Pest Control Products Board
PHI	Pre Harvest Interval
PIM	Participatory Irrigation Management
TARDA	Tana Athi River Development Authority
WHO	World Health Organization

ABSTRACT

Agriculture is one of the three most hazardous occupations in terms of safety and health due to the physical strain and repetitive movements associated with its tasks among others. It is however the mainstay of the Kenyan economy contributing 26% of the GDP annually and providing about 70% of the informal employment. This sector has recorded the highest number of non-fatal injuries compared to other sectors of the economy in the country over the years. This study was conducted to evaluate the work related injuries and ill health among farm workers in irrigation schemes in Kenya. The study adopted a longitudinal design and from a population of 21,561 a sample of 380 farm workers were randomly selected from three public irrigation schemes of Ahero, Perkerra and Mwea. Data was collected through observation, cross-sectional survey and focus group discussions. An intervention was carried out at Mwea irrigation scheme involving 40 farm workers through one crop cycle. The data collected was analysed using SPSS ver. 20 and presented in descriptive statistics. Inferential statistics was carried out using Chi Square tests and the results presented using charts and tables. The study found that farm workers were exposed to a variety of occupational hazards that includes biological, physical, chemical and ergonomic. In all the schemes, over 90% of the respondents had been injured at work with the major causes of the injuries being working tools and machinery. The body part that received majority of the injuries was the leg and the hand with the key tools responsible for the injuries being the hoe and machete. Chemical poisoning was one of the causes of ill health with symptoms of the serious cases being headache, dizziness, breathing problems and vomiting leading to hospital admissions. Other ill health cases reported by the farm workers included malaria, bilharzia, typhoid, back pains, and aching bones. Information collated from the HCP indicated the main ailments treated as malaria and gastrointestinal ailments at Ahero; URTI and typhoid for Perkerra and URTI and skin ailments for Mwea. The main constraints to application of good OSH practices included lack of effective training; lack of advisory services; ignorance of the existence of the OSH law; lack of knowledge and economic ability to procure PPE. The estimated economic losses excluding fatalities was 5.7% for all public irrigation schemes earnings in Kenya. The intervention adopted a training model that produced good results after training. The study concluded that farm workers were at a high risk of accidents and ill health due to exposure to uncontrolled biological, chemical, physical and ergonomic hazards; the government does not consider farm worker's safety and health as a key driver of vision 2030; effective safety and health training is inadequate to empower the farm workers to manage the hazards. The study recommends that the county governments should give priority to the provision of drinking water and sanitary facilities in the farms while the central government should come up with guidelines on OSH in agriculture to facilitate compliance with OSH requirements in small scale farming, and offer effective participative training.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

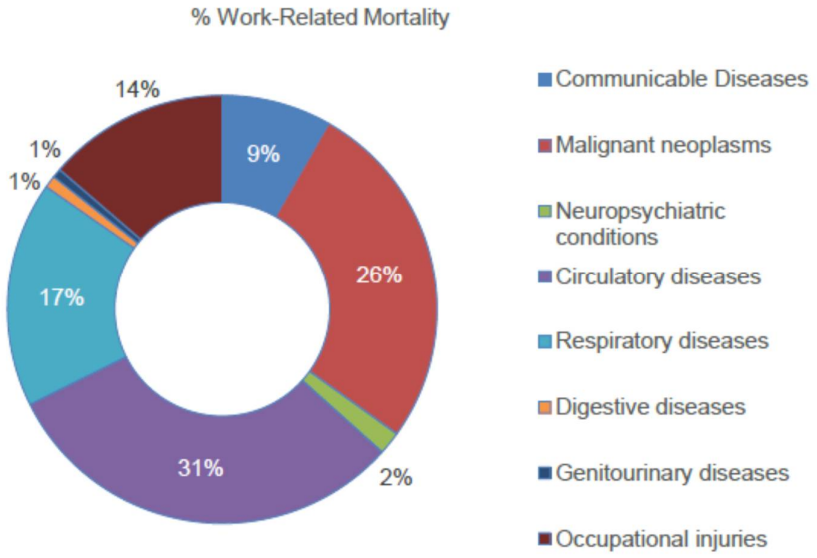
Agriculture is the second greatest source of employment worldwide after services accounting for over more than one third of global employment (International Labour Organization [ILO], 2010). It is also one of the three most hazardous sectors in the world in terms of safety and health together with mining and construction (Cakmur, 2014) (Chattha, Corscadden, & Zaman, 2017). The physical strain and repetitive movements associated with many agricultural tasks can deform bones and injure ligaments and muscles especially in the back causing life-long disabilities (Pascuzzi & Santoro, 2017). The increased use of agricultural chemicals and motorised agricultural machinery by farmers in developing countries has resulted in increased rates of injury and poisoning among workers (ILO, 2012).

At least 170,000 agricultural workers die each year in the world while millions are seriously injured in work related activities. Workers in the agricultural sector run twice the risk of dying compared with other sectors (ILO, 2014). While farm workers face workplace hazards similar to those found in industrial settings, such as working with heavy machinery and hard physical labour, they also face unique occupational hazards such as pesticide exposure, heat and sun exposure, hazardous tools and machinery among others. Lack of access to quality medical care makes the risks even worse.

In the United States of America, 374 farmers and farm workers died from work related injuries in 2012 resulting in a fatality rate of 20.2 deaths per 100,000 workers with the leading cause of the fatalities being tractor overturning (Centre for Disease Control [CDC], 2014). An estimated 14,000 youths were injured on farms with 2,700 being due to farm work.

The ILO believes that work-related accidents and ill-health can be prevented, and that action is needed at international, regional, national and enterprise levels to achieve this

(ILO, 2005). The ILO and WHO estimates that 5 – 7% of all fatalities in industrial countries are attributed to work related injuries and ill health but the Figure may be lower in developing countries since they have major challenges in primary health care. Globally 2.78 million deaths occur annually due to work related injuries and ill health with 2.4 million being due to work related ill health and the rest due to injuries (Hamalainen, Takala, & Kiat, 2017). Figure 1.1 below shows the work related mortality by cause in 2015. The main causes of death from work related illness were circulatory diseases (31%), malignant neoplasm (26%), respiratory diseases (17%), and occupational injuries (14%).



(Hamalainen, Takala, & Kiat, 2017)

Figure 1.1: Causes of work related mortality

In the 2010/2011 report on occupational accidents in Kenya, there were a total of 249 fatalities and 5,774 non-fatal accidents reported. Out of these, the Agricultural and related activities sector reported 14 fatalities and 1350 non-fatal accidents which was by far the highest in the country that year (ILO, 2013). Conversely the construction sector reported 40 fatalities and 383 non-fatal accidents while mining reported 15 fatalities and 40 non-fatal accidents. It is believed that there was under reporting due

to lack of knowledge from the small scale traders and farmers considering the diversity of their locations and exposure.

Agriculture is a major stakeholder to food security and is the main stay of most developing countries (Olowogbon, 2011). An estimated 1.3 billion workers are active in agriculture representing over 50% of the total global workforce (Forastieri, 1999) (ILO, 2000). Agriculture is the mainstay of the Kenyan economy directly contributing 26 per cent of the GDP annually, and another 25 per cent indirectly. Figure 1.3 shows the contribution of Agriculture to the GDP from 2013 to 2017. It can be seen that the sector contributed between 26.1 to 31.5% of the national GDP within that period. The sector accounts for 65 per cent of Kenya's total exports and provides more than 70 per cent of informal employment in the rural areas (GOK, 2010) (GOK, 2015). Therefore, the agricultural sector is not only the driver of Kenya's economy but also the means of livelihood for the majority of Kenyan people. The agricultural sector in Kenya is made up of four sectors namely, industrial crops; food crops; horticulture; and livestock and fisheries. The industrial crops include coffee, tea, cotton and sugarcane while horticulture crops include fruits, vegetables and flowers. Food crops include maize, wheat and rice.

Table 1.1: Contribution of Agriculture in Kenya to the GDP 2013 - 2017

	Percentage Contribution to GDP				
Industry	2013	2014	2015*	2016*	2017*
Agriculture, forestry and fishing	26.4	27.5	30.2	32.1	31.5
Growing of crops	18.4	19.7	23.0	25.4	24.9
Animal production	5.3	5.1	4.7	4.5	4.4
Support activities to agriculture	0.6	0.6	0.6	0.5	0.5
Forestry & logging	1.4	1.3	1.3	1.3	1.3
Fishing & aquaculture	0.7	0.7	0.6	0.5	0.5

Source: KNBS, 2018

The Kenyan Vision 2030 identifies agriculture as a key sector in the strategy that will drive the country in to realizing the targeted average GDP growth rate of 10% annually in the next 25 years. The sector will therefore be expected to open new frontiers and

provide opportunities for growth (GOK, 2007). The vision identified the major challenges as productivity, land use, markets and value addition. The Vision aims to create a globally competitive and prosperous country with a high quality of life by the year 2030 (GOK, 2007). For the country to achieve the aspirations of the Vision there is need to improve the safety and health of workers in the main sector that drives the economy.

In achieving this vision, the Government of Kenya plans to increase productivity through provision of widely accessible farm inputs and services. In addition the Government plans to increase the land under cultivation by irrigating idle land in the arid and semi-arid lands. Value addition of the crops produced is another area that the Government has identified as a driver to the improved economic performance (GOK, 2015).

The annual fertilizer demand increased from 329,449 tonnes in 2002/03 to 410,214 tonnes in 2006/07 while the volume of pesticide imports reached 7000 tonnes in 2006/07 (MOA, 2010). Developing countries consume more than 20% of the world production of agrochemicals and are responsible for approximately 70% of the total number of cases of acute chemical poisoning occurring in the world, which corresponds to more than 1.1 million cases (Forastieri, 1999). There is need for dramatic improvements in the standards of protection both with regard to waged workers and farmers before agriculture can become socially and environmentally sustainable. Workers in Agriculture shall have the right to be informed and consulted on safety and health matters including risks from new technologies (ILO, 2001) for the improvements to be realised.

1.2 Statement of the problem

The Government of Kenya has identified agriculture as one of the key drivers of the economy for the achievement of industrialization status by the year 2030. The envisaged improvement in productivity and value addition of locally produced crops will increase usage of agricultural chemicals and increase in the use of machinery in the sector that employs a large number of Kenyans. The high number non-fatal injuries

in the agricultural sector in Kenya (ILO, 2013) in addition to the estimated loss of 4% of the GDP due to work related accidents (ILO, 2002) (Hamalainen, Takala, & Kiat, 2017) gives a gloomy picture on the future of food production due to the deterioration of the health of the agricultural workers. Although there is evidence to show that occupational safety and health is a concern in Kenya by having a directorate (DOSHS) within the Ministry of Labour and Social Protection, there is little quantitative information upon which a control program can be developed in the agricultural sector. The envisaged increase in irrigated land combined with the increase in productivity by use of fertilizers and chemicals and investment in machinery and technology for value addition has the effect of increasing the occupational safety and health risks within the agricultural sector hence the selection of this study.

1.3 Justification of the study

In Kenya, 30% of the food consumed by rural households is purchased while 70% is derived from own production (GOK, 2009) while in urban areas all the food consumed is purchased. Sustainability of own/labour production is dependent upon the health of the worker since poor health results in low availability of the farm worker for production. There is a need for effective intervention at farm level in order to improve farm safety and health and in so doing reduce farm injuries and farm fatalities. However, to proceed, accurate information is required in order to guide strategic planning in this area.

The vision 2030 aims at improving food production to ensure self-sufficiency and surplus for export by irrigation of more land in the arid and semi-arid areas (GOK, 2007a). Production of the main food crops of maize, wheat and rice has generally been below the country's consumption requirements (GOK, 2010).

The outcome of the study with the associated intervention shall inform future research in the field of occupational safety and health on the nature of hazards, injuries and ill health associated with the Kenyan farm workers. It shall also inform the OSH regulator on the need to have a critical focus on the farmer's safety and health if food production and sustainability will be achieved in Kenya as envisaged in the vision 2030.

1.4 Objectives

1.4.1 Main objective

The main objective of this study was to evaluate work related injuries, ill health and associated costs among farm workers in public irrigation schemes in Kenya.

1.4.2 Specific objectives

a) To assess the occupational safety and health hazards that Kenyan irrigation farm workers are exposed to in the course of their work
b) To appraise the work related injuries and ill health that occur on the irrigation farm workers in Kenya and their sources
c) To explore the constraints that hinder good occupational safety and health (OSH) practices in irrigation farms in Kenya
d) To estimate the economic loss caused by the injuries and ill health to the irrigation farm workers in Kenya
e) To develop and test a mitigation matrix for the control of injuries and ill health in the public irrigation schemes in Kenya.

1.5 Research questions

a) What are the significant OSH hazards encountered by irrigation farm workers in Kenya?
b) To what extent are the work related injuries and ill health significant within the farm workers in Kenya?
c) What are the constraints that hinder good occupational safety and health (OSH) practice in Kenya irrigation schemes?
d) What is the estimated economic loss that can be attributed to occupational injuries and ill health for irrigation farm workers in Kenya?
e) What strategies can be applied in Kenya irrigation schemes to mitigate the work related injuries and ill health?

1.6 Scope of the study

The ILO describes agriculture as agricultural and forestry activities carried out in agricultural undertakings including crop production, forestry activities, animal husbandry and insect raising, the primary processing of agricultural and animal products by or on behalf of the operator of the undertaking as well as the use and maintenance of machinery, equipment, appliances, tools, and agricultural installations, including any process, storage, operation or transportation in an agricultural undertaking, which are directly related to agricultural production. This definition excludes subsistence farming; industrial processes that use agricultural products as raw material and the related services; and the industrial exploitation of forests (ILO, 2001). The current study will however concentrate on food crop production for both commercial and subsistence purposes. It will exclude any industrial activity related to the crops under study since the work beyond this stage is likely to be handled by other workers who are not necessarily farm workers.

1.7 Conceptual Framework

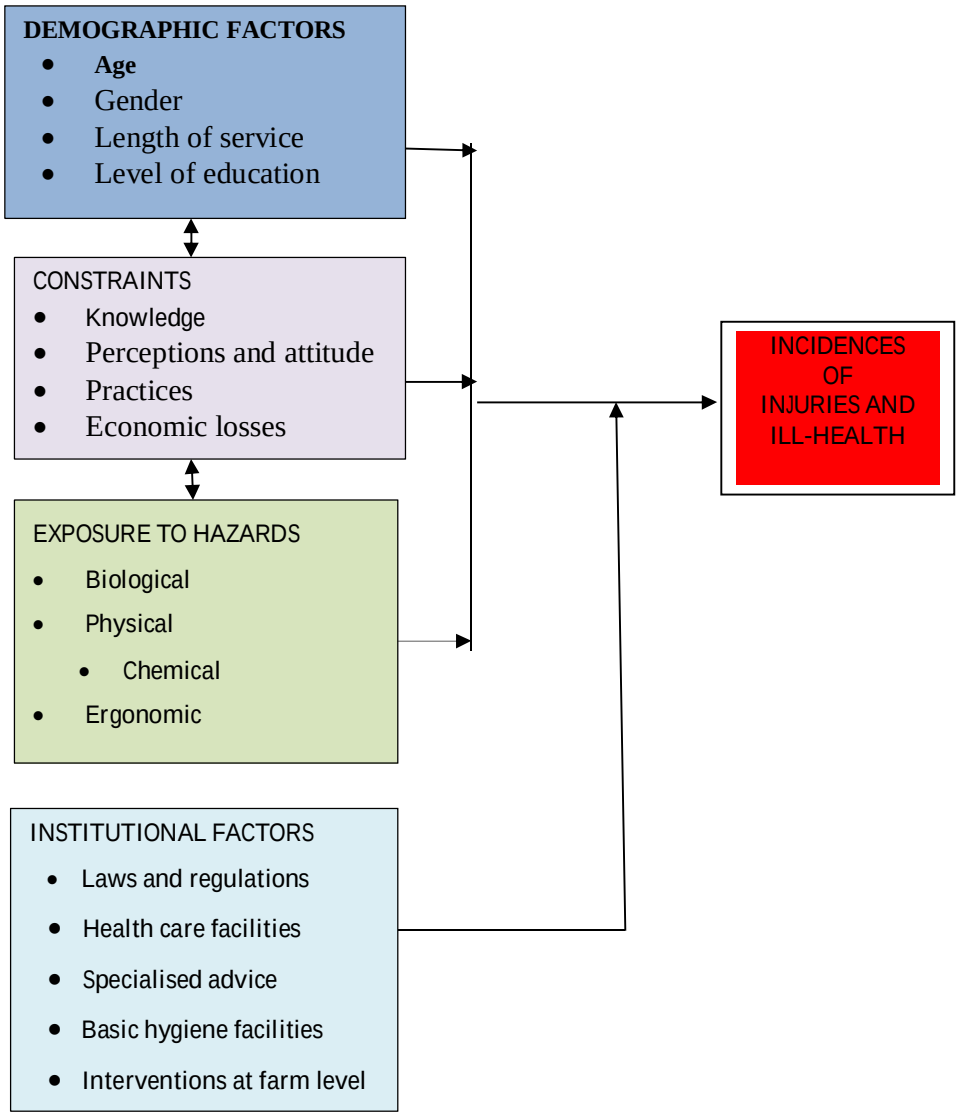


Figure 1.2: Conceptual framework

The types of hazards, their intensity and length of exposure determines the probability and consequences of an injury or ill health occurring. Further, demographic factors and constraints contribute to the level of vulnerability. These however may be intervened by institutional factors by obeying laws and regulations, getting specialised advice from the government officers (MOA, DOSHS etc.) (Fig 1.2).

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical Principles

Agriculture and rural development are sustainable when they are ecologically sound, economically viable, socially just, culturally appropriate, humane, and based on a holistic scientific approach (Hurst, 2005). Sustainable agriculture must therefore meet the nutritional requirements and other human needs of present and future generations, provide durable and descent employment and reduce vulnerability of the workforce. Occupational safety and health has been identified as having a strong influence to all sectors of the economy and hence its effective management can deliver improved productivity and efficiency (Olowogbon, 2011).

Much agricultural work is by its nature physically demanding, involving long periods of standing, stooping, bending and carrying out repetitive movements in awkward body positions (Hurst, 2005). The risk of accidents due to fatigue, poorly designed tools, difficult terrain, exposure to adverse environmental conditions, use of chemicals and machines without appropriate safety measures makes farmers and farm workers vulnerable to work related accidents and illness.

Due to the hazardous nature of agricultural occupations and the often remote location of the farms, medical care is a critical ingredient that lacks in most developing countries Kenya included. The World Health Organization (WHO) estimates that around 1 billion poor people worldwide have no access to health facilities with agricultural workers making the highest percentage (Hurst, 2005). Some of this people lack proper sanitation and safe drinking water. Lack of hygiene facilities in the farm place the farmers and their children at risk of health hazards and contracting many diseases. Small scale farmers are vulnerable to greater risks due to insufficient knowledge, limited access to resources and information on hazard identification and risk management and being outside the scope of labour and health inspections (ILO, 2014).

2.1.1 ILO: The Safety and Health in Agriculture Convention

The Safety and Health in Agriculture Convention, 2001 (No 184) was the first international instrument that addresses the safety and health hazards facing workers in agriculture in a comprehensive manner. It proposed a framework on which national policies can be developed together with mechanisms to ensure the participation of workers' and employers' organizations. The Convention discussed general and specific preventive and protective measures and came up with recommendations entitled R192 Safety and Health in Agriculture Recommendation, 2001 (No 192). The recommendations include such areas as machinery safety and ergonomics, sound management of chemicals, animal handling and protection against biological risks, agricultural installations and welfare facilities. The other specific recommendation was on self-employed farmers where the key issues are as listed below:-

a) National laws and regulations should specify the rights of self-employed farmers with respect to safety and health in agriculture
b) Farmers should be taken into consideration in the formulation , implementation and periodic review of the national policy
c) The competent authority should ensure that self-employed farmers enjoy safety and health protection afforded by the convention

2.1.2 ILO: Code of practice on safety and health in agriculture

The ILO has developed a code of practice that is dedicated to the farmers and agricultural workers who feed the world in the expectation that it will improve safety and health in agriculture (ILO, 2010). The codes of practice are technical standards which provide guidance for specific sector or topic areas. This code complements the Safety and Health in Agriculture Convention 2001 (No 184) and it's supplementing Recommendation (No 192). It provides guidance on appropriate strategies to address the range of occupational safety and health risks encountered in agriculture in order to prevent – as far as is reasonably possible – accidents and diseases for all those engaged in this sector. The majority of the agricultural workers are women and hence the code takes into consideration the gender dimensions of OSH in agriculture.

The code of practice in agriculture identified the main contributors to injuries and ill health to include among others working with machines, vehicles, tools and animals; exposure to excessive noise and vibration; slips, trips and falls from heights; lifting heavy weights and other work giving rise to musculoskeletal disorders; exposure to dust and other organic substances, chemicals, and infectious agents; and other working conditions common to rural environments, such as exposure to extreme temperatures, inclement weather and attacks by wild animals (ILO, 2010).

This code of practice does not apply to forestry since there is a separate ILO code of practice namely Safety and Health in forestry work, 1998. While the convention does not apply to subsistence farming, some provisions of this code may be helpful in preventing accidents and diseases even in very small enterprises that includes subsistence farming. The code requires the competent authority to support the establishment and operation of an education and training system catering for the needs of the agricultural sector with a view to raising the knowledge and skills level in occupational safety and health in agriculture to be able to identify and eliminate or control work related hazards and risks.

2.1.3 OSH Hazards in Agriculture

A hazard may be defined as a danger to workers that is inherent in a particular occupation, in farming, farm workers are exposed to a variety of hazards that are unique to the occupation. These includes but not limited to pollen, fungal spores, animal dander, grain dust and mites (Gerrald, 1998). When compared with other workplaces, agriculture has unique and inherent characteristics that result to different OSH hazards.

The most frequent hazards in agriculture include use of hazardous chemicals, machinery, toxic and allergic agents (plants and pests), ergonomic hazards caused by repetitive work, lifting and carrying of heavy loads, unique body postures and other infectious parasitic diseases according to the ILO (ILO, 2000). The occupational hazards of farming in Canada have been listed (White & Cessna, 1989) as use of farm

machinery, biological hazards, risk of cancer, psychosocial stress and use of chemicals.

2.1.3.1 Chemical hazards

Chemicals in the farms are used for spraying pests, removing weed, preservation of seeds. The pesticides that help protect crops from pests may result in adverse health effects to the user (Sheira and Cesar, 2015). Farm workers are known to use fertilizers, pesticides, fungicides and herbicides. These chemicals have the potential to cause ill health to the farm workers (Oztas, Kurt, Koc, Akbaba, & Ilter, 2018) and they may be in gaseous form, solid or even liquid. The main entry of the chemicals is through dermal exposure, inhalation and ingestion.

2.1.3.2 Biological hazards

Biological hazards are associated with working with animals, people or infectious plant materials. Work in farms and other outdoor occupations is likely to expose workers to biological hazards. Bacteria, viruses, fungi and protozoa are among the biological hazards that are capable of causing harm to the body through intentional or unintentional contact. Farm workers are exposed to contact with wild and poisonous animals that includes insects, spiders, scorpions, snakes, and other poisonous plants (ILO, 2000).

2.1.3.3 Ergonomic hazards

Ergonomics hazard occur when the type of work, the body position and the working conditions put strain on the body. The use of inadequate equipment and tools, unnatural body position, prolonged static posture, carrying of heavy loads and working long hours are some of the factors that give rise to ergonomic hazards in agriculture.

Other factors include:-

a) Frequent lifting
b) Poor posture

c) Awkward repetitive movements
d) Using too much force frequently
e) Vibrations

Agricultural work can span a wide range of tasks from arduous to sedentary, from stooping, reaching, bending, and carrying out repetitive movements in awkward body positions to sitting (ILO, 2010). It is characterized by labour-intensive practices such as manual transplanting rice, fresh vegetables, or horticultural products, crop maintenance that includes weeding, pruning, grafting, or hand tillage, harvest that is hand picking of fresh fruits and vegetables, or post-harvest activities of inspection, packing, or loading.

2.1.3.4 Physical hazards

Physical hazards are factors within the environment that have the potential to harm the body. These include but not limited to extremes of temperatures due to weather conditions, loud noise, radiation – ionizing and non-ionizing, use of tools and machinery. The most commonly used machinery in farming are tractors, cultivators, trailers, animal driven carts, mowers, balers, harrows, sprayers etc. A wide range of tools are also used for carrying out repairs, hoe, knives and machetes. The principal risks include traumatic injuries which may occur during production or even during maintenance, cuts, burns and fractures (ILO, 2010). The effect of the injuries may be made serious by the fact that many farm workers work alone and the first aid facility may be far or non-existent.

The common physical hazards associated with ill health include wet work, work in extremes of temperatures among others. Wet work is defined as activities where workers have to immerse their hands or feet in liquids for more than 2 hours in a working shift (Behroozy, and Keegel 2014). Frequent exposure to water causes swelling leading to dermatitis. This may also lead to maceration and cutaneous irritation of the skin. People exposed to wet work should wear water resistant gloves and water resistant shoes (gum boots). High temperatures exposes workers to heat with the most likely illness being heat stroke. Heat stroke occurs when the body's

temperature regulating system fails resulting in critical levels of body temperature above 40^{o}C. Signs of heat stroke include confusion, loss of consciousness and seizures. Body temperatures above 38^{o}C are likely to cause heat exhaustion (OSHA, 2014).

2.2 Legal framework with respect to Agriculture

In the United States of America, Occupational Safety and Health Administration (OSHA), which is a national public health agency dedicated to the basic proposition that no worker shall have to choose between their life and their job. Under OSHA, standards are developed to protect workers from a wide range of serious hazards eg in Agriculture where OSH standard 29 CFR 1928 deals with hazards specifically applicable in farms inclusive of physical, biological and other hazards (OSHA, 2018).

In the United Kingdom, occupational safety and health is managed by the Health and Safety Executive (HSE) through enforcement of the Health and Safety at Work Act, 1974 with amendments of 2008. The HSE enforces the law in many workplaces that includes safety in the farms. In execution of their duty, they are assisted by over 380 local authorities across the UK. HSE has developed regulations, codes of practice and many publications (guidelines) to assist in compliance of the main Act in various sectors of the economy that includes agriculture (www.hse.gov.uk).

In Kenya, the history of Occupational Safety and Health dates back to 1950 when it was found necessary to have a legal instrument to manage the safety, health and welfare of employed persons in factories. The colonial government by then adopted the British Factories Act of 1937. In 1990, the Factories Act was amended to Factories And other Places of Work Act for purposes of enlarging the scope of coverage. In the year 2007, the Factories and Other Places of Work Act was repealed and replaced with the Occupational Safety and Health Act (GOK, 2007). In the same year, the Work Injury Benefit Act was enacted and is also managed by Directorate of Occupational Safety and Health Services.

2.2.1 The Occupational Safety and Health Act, 2007

The purpose of the Occupational Safety and Health Act, 2007 is to secure the safety, health and welfare of persons at work and to protect persons other than persons at work against risks to safety and health arising out of, or in connection with, the activities of persons at work. The purpose of The Work Injury Benefits Act (WIBA) on the other hand is to provide for compensation to employees for work related injuries and diseases contracted in the course of their employment and for connected purposes. Though compensation applies to all workers, it is contributory and hence self-employed workers who includes small scale farmers do not enjoy the services of this legislation.

The Directorate of Occupational Safety and Health Services (DOSHS), is a department within the Ministry of Labour that is responsible for Occupational Safety and Health services in the country. It has the mandate to ensure compliance with the provisions of the Occupational Safety and Health Act (OSHA), 2007 which promotes safety and health of workers, and the Work Injury Benefits Act (WIBA), 2007 through prompt compensation of employees against work related injuries. The directorate currently has representation in 29 out of 47 counties within the Republic of Kenya with the other counties being managed from the established 29 (ILO, 2013), (DOSHS, 2017).

The Directorate is guided by its Vision, "A healthy worker in a safe work environment" in undertaking its mandate and responsibilities. The mission of the Directorate is to develop and implement effective systems for the prevention of workplace diseases, ill health and accidents in order to reduce damage to property and work injury compensation claims for improved productivity.

The OSH Act of 2007 applies to all work places where any person is at work whether temporary or permanent. The law gives duties to employers, self-employed persons and employees. In all cases workers are required to ensure their own safety and that of any other person within their work environs. In addition, workers are required to use appropriate safe systems of work, preventive control measures including personal

protective equipment and clothing, where necessary and comply with the rules and regulations issued under the act.

The occupational safety and health act in Kenya does not explicitly mention agriculture in the text except in the list of occupational diseases where exposure to moulded hay is cited to be a contributor to pulmonary disease due to inhalation of moulded dust (OSHA, 2007). The Act requires that manufacturers, importers, suppliers and distributors of chemicals must avail to an employer, material safety data sheets for chemicals and other hazardous substances. The Material Safety Datasheets (MSDS) contain crucial information, including the handling, use, and precautions to take including advice on personal protective equipment. It also gives guidelines on emergency action in the event of fire, spillage, and first aid requirements. Other information provided in the Material Safety Data Sheets is on the ecological hazards in case the chemical is misused, safe waste disposal of the containers, relevant regulations, references in case of enquiries; name, address, and telephone number of suppliers, date of expiry and the pre harvest interval (P.H.I.) to be observed. The 'toxicological information' will include antidotes and medical measures, symptoms of poisoning and statement of the ingredient that may affect the treatment. The Act also requires that any person supplying, distributing, transporting or storing chemicals or other toxic substances should ensure that they are packaged, conveyed, handled and distributed in a safe manner (OSHA, 2007).

2.2.2 Hazardous Substance Rules

The Factories and other Places of Work Act (Hazardous Substance) Rules, 2007, gives Occupational Exposure Limits (OELs) for people exposed to hazardous substances. According to part (7) of the Hazardous Substance Rules, Substances used as active ingredients in pesticides are listed under their chemical names and/or their common names. These names may sometimes be used as parts of the names of proprietary pesticide formulations. In all cases the exposure limit applies to the specific active ingredients and not to the formulation as a whole (GOK 2007b).

Apart from the two laws administered by the Directorate of Occupational Safety and Health Services, there are other legislations that touch on Occupational Safety and Health namely Public Health Act, Environmental Management and Coordination Act, Radiation Protection Act, Pest Control Product Act, among others. These laws are enforced by different ministries and departments of the government (ILO, 2013).

2.2.3 Pest Control Products Act

The Pest Control Products Act, 1982, regulates the importation, exportation, manufacture, distribution and use of products used for the control of pests and of the organic functions of plants and animals and for connected purposes. At the same time, the Pest Control Products Board was established to enforce the Act through assessment and evaluation of pest control products and registration of pest control products.

The Pest Control Products Board is a statutory organization established in 1985, to regulate pest control products traded within Kenya. The underlying factor necessitating the formation of the Board was the recognition of the fact that although pesticides are key to agricultural production, they are toxic substances that can be harmful to both human life and the environment. The Board is mandated to oversee all matters related to pesticides, including but not limited to the regulation of the importation and exportation, manufacture, advertisement, supply, storage, distribution and use of pest control products, while mitigating their potential harmful effects to the environment.

Under the Act, pesticides are classified into 3 categories. The first one is the restricted class, with an acute oral dose of less than 50mg/kg that can kill at least 50% of the target pest. This class of pesticides has significant environmental risks. The second class is the commercial and agricultural class with an acute oral dose of between 50mg/kg and 100mg/kg. With this class, the environmental effect is possible in limited regions. Class three is the domestic class with an acute oral dose greater than 500mg/kg. This class requires no special precautions or equipment for inhalation hazard, has no irreversible effects from repeated exposures, disposal of product and

containers can safely be done by placing in garbage and the package sizes are limited to amounts that can be safely used and stored by consumers (Pest Control Products (Kenya) Act, 1982, Cap 346).

2.3 Irrigation farming in Kenya

There is no national policy on irrigation in Kenya but there are various acts of parliament that give various organizations mandate to undertake irrigation activities. They include Irrigation Act cap 347, Tana Athi River Development Authority (TARDA) Act cap 443, Coast Development Authority (CDA) Act cap 449, Ewaso Nyiro North Development Authority (ENNDA) Act cap 448, Kerio Valley Development Authority (KVDA) Act cap 441, Lake Basin Development Authority (LBDA) Act and Ewaso Nyiro South Development Authority (EWNSDA) Act and Agriculture Act Cap 318 resulting in uncoordinated irrigation development. There is however a move to have a draft policy to be approved by both the Cabinet and the Parliament for enactment.

There are three categories of irrigation systems in Kenya (Water Sector Trust Fund, n.d.):-

i. Private schemes which are developed, owned and managed by individual farmers or companies as commercial enterprises
ii. Public schemes that are developed and centrally managed by government agencies that give farmers tenancy rights for crop production activities
iii. Smallholder community irrigation schemes that are owned, operated and managed by farmers through their irrigation water users association (IWUA). These are developed on cost sharing basis by the government, community and development partners.

The public irrigation schemes in Kenya are managed by the National Irrigation Board (NIB). The board was established and incorporated in 1966 as a state corporation through the Irrigation Act, Cap 347 of the laws of Kenya revised in 2013 (GOK, 2013). Among the mandates of the board includes - Coordination of construction and rehabilitation of major irrigation and drainage infrastructure; Operation and

maintenance of major irrigation and drainage infrastructure; and administering land in the public schemes and providing technical advice to farmers. NIB is currently managing seven national irrigation schemes namely, Mwea, Perkerra, Hola, Ahero, West Kano, Bunyala and Bura. In these schemes, NIB undertakes the development, operation and maintenance of irrigation infrastructure through which it conveys irrigation water to the crop land.

The Irrigation (National Irrigation Schemes) regulations, 1977 (LN 68/1977) revised in 2012 (GOK, 2012) provides the rules to be followed in the management of the schemes. Among the rules states that the occupants of the scheme shall not construct a building or other works of any kind in the scheme without prior consent from the scheme manager in writing. The manager also has the right to treat any crop or stocks to protect them against disease, pests or damage of any kind and recover the costs from the plot occupiers.

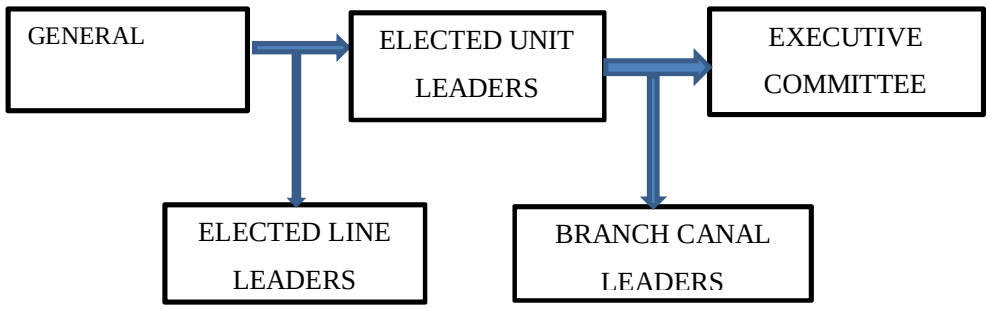
Irrigation in Kenya is hindered by many factors the main systemic barriers being water availability and quality, power availability and costs and provision of support services (FAO/IFC, 2015). Farmer groups are widespread in Kenya and are used as a primary channel for the provision of public extensions services and advice. Farmers at the national irrigation schemes are bound by the Irrigation (national irrigation schemes) regulations, 1977 that binds them to produce crops that have been prescribed to them by the scheme manager and pays the prescribed fees monthly for the provision of irrigation water to his/her plot.

Table 2.1 gives some important data for the three selected irrigation schemes. The schemes had high temperatures particularly Perkerra with a maximum of 37^0C and low rainfall of 630 mm. The main crops grown were rice in both Ahero and Mwea while at Perkerra, the main crop was maize seed under contract from seed companies.

Table 2.1: Basic information on the selected irrigation schemes

	Ahero	Perkerra	Mwea
County	Kisumu	Baringo	Kirinyaga
Management	PIM	PIM	PIM
Area covered (Ha)	2,168	2,350	10,318
Max temperatures 0C	30	37	31
Ave temperature 0C	23	24.6	21.5
Min temperatures 0C	17	16	17
Annual Rainfall (mm)	1215	630	1026
Main crop	Rice	Maize seed	Rice

The three irrigation schemes were managed through participatory irrigation management (PIM) approach where farmers through Irrigation Water Users Association (IWUA) fully participated in the scheme management. All plot holders were members of the association whose leadership was elected by the members based on block representation. The National Irrigation Board (NIB) managed the main canals while IWUA carried out operations and maintenance of the tertiary infrastructure and distribution of the irrigation water. The NIB had no direct authority over individual plot holders and hence could not be considered as the occupier for purposes of the OSH Act, 2007. The application of the Act was therefore based on self-employed persons (small scale farmers). Figure 2.1 gives the structure of IWUA.

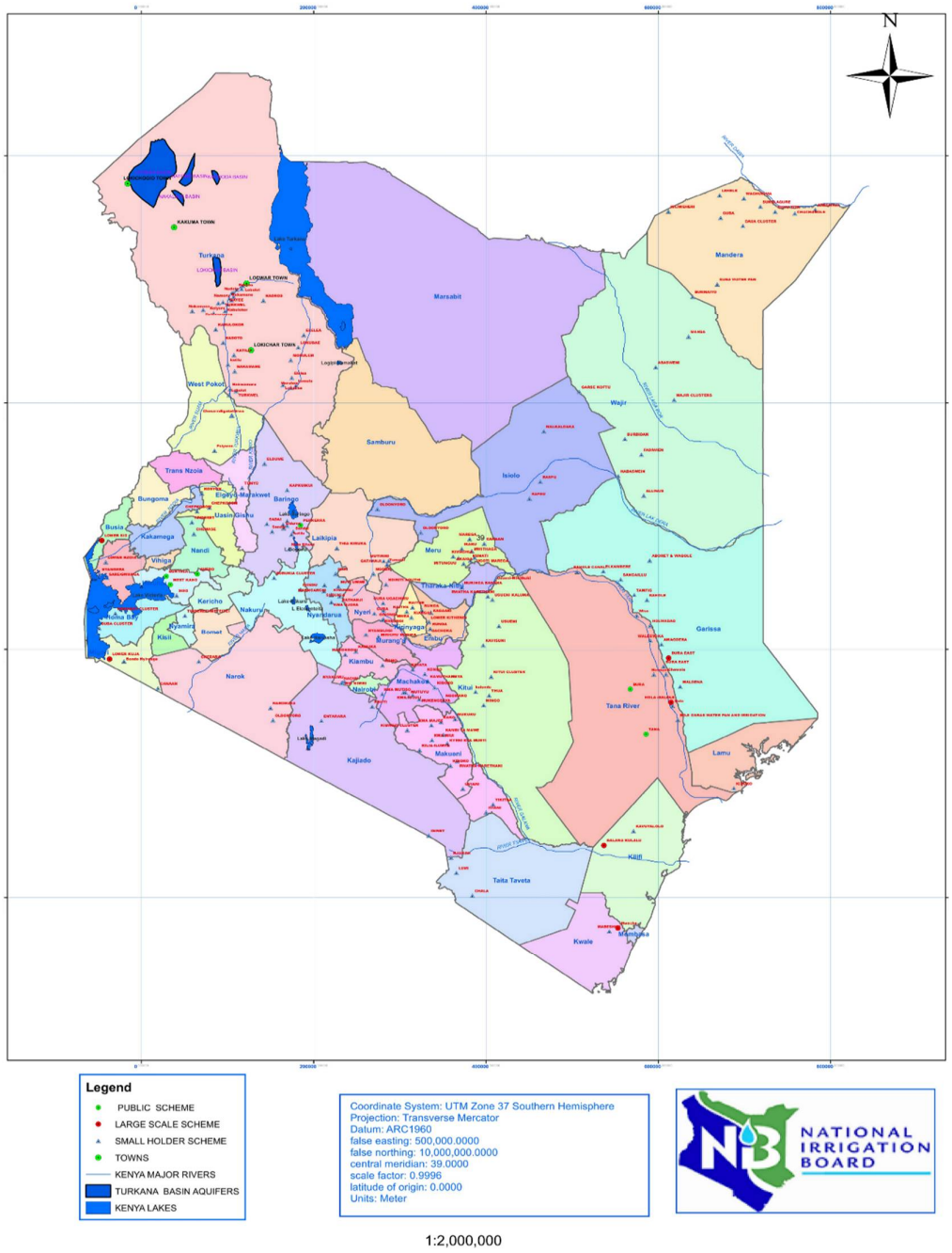


Source – NIB, Mwea, 2016

Figure 2.1: Management structure of the IWUA

The plot owners elected their leaders – Line leaders and unit leaders (Figure 2.1). The unit leaders in turn elect branch canal leaders and the executive committee from among themselves. The executive committee is the link between plot holders and the service provider (NIB) where they hold bimonthly meetings to discuss the service delivery and any shortcomings addressed. The chairman of IWUA is provided with an office, a secretary and a board room by the NIB.

The future of farming in Kenya lies in irrigation as clearly stated in the Vision 2030 and in compliance to this vision, NIB was undertaking new developments as well as rehabilitating old irrigation schemes that amounted to 169 projects (NIB, 2016). The aim was to have one million acres of land under irrigation within 5 years. The map (Fig 2.2) below shows the distribution of the irrigation projects within the 47 counties in Kenya most of them being smallholder community irrigation schemes.



Source NIB, 2016)

Figure 2.2: Distribution of irrigation projects in Kenya

2.4 Previous works relevant to the study

2.4.1 Occupational hazards

Production agriculture workers are at a higher risk of death or disabling injury than most other workers (Von Essen and McCurdy, 1998). The report cited cases of traumatic injuries arising from the use of machinery and animal handling. Respiratory ailments were also highlighted caused by grain dust, dust and gases in animal confinement units, moulds and thermophilic bacteria in hay and gas. Other hazards identified include hearing loss, chemical poisoning, skin disorders, zoonosis, heat and cold stress, and musculoskeletal disorders.

One of the risks the farmers encounter is the exposure to chemicals that includes pesticides. Some of these airborne hazards are capable of producing acute or chronic health problems such as asthma, extrinsic allergic alveolitis and bronchitis (Gerrard, 1998). According to Gerrard, agriculture when compared with other industries has unique and inherent set of characteristics resulting in safety and health problems different from other forms of occupations.

In Gambia, a study was undertaken to provide direction for the development of a model occupational safety and health program and policy for the country (Kuye, Donham & Marquez, 2006). The study applied three methods for data collection:-

i. Walk through survey using a hazard checklist. Four farms were visited that grew peanut, rice, vegetables and small grain all in different districts. Observations were made on farm tools and equipment, and answers from the farmers responding to oral questions covering potential risks, injuries and illness. 72% of the farmers were found to be inhaling large amounts of smoke and dust during land preparation and harvesting. Other risks included exposure to chemicals and ergonomics.
ii. Cross sectional survey that used three sets of questionnaires for farmers, nurses and agricultural extension workers. 20 farmers, 20 extension officers and a convenient number of nurses were interviewed using closed and open ended

questionnaires. 79% of the farmers reported injuries in the farm in the last 1 year with 50% of the injuries having occurred during land preparation and weeding.

iii. A full day stakeholder's seminar and workshop was held on safety and health with 30 participants representing government departments, parastatals, agricultural and health institutions, farmers association, education institutions. The workshop after discussions came up with recommendations to guide the formulation of agricultural safety and health curricula for educational institutions and a comprehensive agricultural safety and health national policy.

In Kenya, a study carried out to evaluate the safety and health measures taken by tobacco farmers of Eastern Kenya while handling agricultural chemicals (Mburu, 2006) measured the farmer's knowledge, attitude and practices through interview of 40 farmers at Mitunguu, Meru. 92% of the sampled farmers were aware that pesticide poisoning was preventable, with 85% wearing old improvised clothing as personal protective clothing. 72.5% of the sample had received some training on the need to wear personal protective equipment while 39% had fallen sick after spaying the chemicals. The study concluded that there was a strong linkage between the use of chemicals and the ailments encountered at the study site unless proactive measures were taken by means of use of the right personal protective equipment and effective training program for the farmers.

Fathallah (2010), has given an overview of the extent of musculoskeletal disorders (MSD) in agriculture after reviewing literature. The paper states that there are similarities in the general classes of MSD risk factors within the various types of production agriculture. It has listed the three main risk factors that are utmost priority in agriculture as lifting and carrying of heavy loads, sustained or full body bending (stooping) and very high repetitive hand working (Fathallah, 2010). According to this study, in the USA, green house, nursery and vegetable farmers suffered pains at the shoulder, hand/wrist and lower back due to forceful use of hoe, repetitive cutting, stooping and lifting.

In Ethiopia, a study was conducted to assess the knowledge and practices of farmers on pesticide management and implications on human health (Karunamoorthi, Mohammed & Wessie, 2012). Stratified, systematic random sampling was used for the selection of 175 households from the total of 5,161 households. The study was launched through a meeting of members with community leaders, and leaders of agriculture farmer associations and community health promoters. One adult from each one of a total of 175 households was interviewed to assess their knowledge and practice towards pesticide management and its impact on health. The main respondent was the head of the household, who was believed to be equivalent to the farmer interviewed, according to a standardized questionnaire. Data analysis was performed by using SPSS, version 10.1. Range and mean were analysed and appropriate tables, graphs, and percentages were displayed. Level of significance was also determined by using 95% of confidence intervals and *p* value. The results revealed that 99.4% of the respondents were aware of the impact of pesticides on human health, 77.2% made use of empty pesticide containers for various purposes while the most frequent toxicity symptom was headache (58.8%), salivation and vomiting (38.2%), nausea 936.5%) and sneezing (12.5%). The analysis revealed a strong association between the farmer's education status and the reported toxicity symptoms. Only 4% of the farmers had received any form of training on handling pesticides majority of them being illiterate. The investigation results concluded that the farmers had limited awareness about safe pesticide management and undesirable practice. As a result, appropriate communication strategy must be designed by means of electronic and print media to address this predicament.

In Indonesia a risk management of occupational health and safety in rice farmers in Ngrendeng was carried out (Yonelia and Kurniawidjaja, 2012) with the aim of analysing OSH hazards and risk in rice farming. Interviews and an observation checklist were used to collect data from 5 farmers, the area headman and one land and machine owner. A Job Hazard Analysis (JHA) form and electronic transcriptions were used to record source's answer. The research was a surveillance using semi-quantitative method and descriptive analysis based on AS/NZS standards on risk management as standard. The variables measured included hazard, risk, risk control,

risk communication, monitoring and review. The study found that rice farming consists of 13 activities with a total of 71 risks. The highest risk was noise, vibration, chemical, ergonomics, Ultra Violet (UV) radiation and health behaviour. The study concluded that rice farming is an agricultural activity with high risks that are harmful to the farmer's health and safety. It recommended OSH programs to be developed to manage the hazards to keep the farmers productive.

A study carried out in Ghana (Muilerman, 2013) sought to identify baseline data on occupational safety and health issues in cocoa farming to enable planning of health and safety interventions and estimate the social-economic impact of work related injuries and illness. A survey was carried out that focussed on 420 adult cocoa farmers from four major cocoa producing regions. About 52% of the farmers reported that they had been injured within the last two years giving an incidence rate of 1.75. Other results showed that all the farmers used agrochemicals some of them banned in the European Union (EU) including DDT. The farmers also lacked knowledge on appropriate personal protective equipment and financial resources to procure them. The farmers made 1.6 work related visits to a doctor with an annual loss of 15 working days due to work related pain, illness or injury with an estimated loss of about US$ 110. The major risk was found to be use and handling of chemicals, lower back pain linked to lifting techniques with stress increasing the risk of cuts. The key recommendation was on raising the level of occupational safety and health knowledge to help in changing the work practices.

A study was carried out on Canadian farms aimed at developing and apply a generic farm safety protocol to hazards that have been identified in previously published studies with a view to raising farm safety awareness (Chattha, Corscadden, & Zaman, 2017). The hazards were categorised and a protocol was developed and applied to establish probability and consequences of injury. The greatest risks were identified as farm ownership, use of farm as residence, and missing roll over protection structures. Other key risks include farmer's accident history, medical condition, work environment, water proximity to the farm, and lack of machinery maintenance among

others. The study recommended an extra effort in the promotion of injury prevention methods and safe work environment.

In Turkey, a study was carried out to evaluate knowledge level of farmers at Cukurova region on the effects of pesticide, toxic symptoms as well as their attitude and practices regarding pesticides (Oztas, Kurt, Koc, Akbaba, & Ilter, 2018). All the 420 farmers interviewed used pesticides but none of them had received any training. 84% of the farmers thought that pesticides could have a negative impact on their health while 5% had experienced medical problems.

2.4.2 Occupational Injuries and ill health

Litchfield attempted to review literature of the occupational injuries and ill-health in agriculture world-wide (Litchfield, 1999) and a survey of the attempts that have been made to estimate the resulting economic and social costs. The findings indicated that in developed countries, tractors and other machinery caused a significant proportion of the accidents and were a major cause of occupational deaths.

Table 2.2: Main causes and types of occupational injury and ill health in agriculture

Cause	Main Injuries / Ill Health
Tractor and other mobile machines	Fatality, crushing, internal injury, ergonomic problem
Combined harvester, conveyors	Fatality, crushing, amputation, internal injury.
Fodder cutter, wheat threshers	Deep wounds, loss of finger/toes
Farm animals	Crushing, fractures, heavy bruising, bites, allergy
Hand tools	Cuts, bruising, strain, ergonomic problem
Lifting	Strain, sprain, distortion, ergonomic problem
Hit by objects	Confusions, cuts
Farm chemicals	Skin and eye irritation/skin allergy, internal poisoning.
Plants/dust	Skin or respiratory allergy
Poisonous animals	Bites, stings

Source: Litchfield (1999)

In developing countries however, prevalent accidents were due to hand tools such as hoes, sickles and cutting instruments. Some of the economic costs of occupational injury and ill-health in agriculture could be quantified directly, such as medical costs, the cost of rehabilitation and loss of earnings while other costs were more difficult to estimate such as loss of opportunity and income foregone for permanent and fatal injury and for the effect on a victim's family.

The study recommended improved collection of occupational health statistics, a better understanding of the extent of ergonomic problems in agriculture, more realistic assessments of the cost of occupational injury and ill-health and the continued need to reduce occupational health disorders by appropriate training and education in agricultural practices. The Table 2.2 shows the main causes and types of injury and ill health in agriculture

A study was carried out in Ireland to examine the status of safety and health in Irish farms (Finnegan, 2007) with specific aims of determining the extent farm related injury and illness, attitudes and practices on the farms and to understand the dynamics involved in creating unsafe working conditions. A survey was carried out by use of a detailed questionnaire to determine the extent of farm injuries and to understand the circumstances under which accidents occurred and the outcomes that result. In order to understand the reality of the day to day activities, an examination of nine farms was carried out using case study approach. The study found that over 80% of the farm work related injuries required a hospital visit with over one third resulting in medical attention as outpatients while 22% were inpatients with some requiring surgery. Chronic back pain accounted for almost 50% of the reported cases while dust related allergies accounted for 23% and farmers lungs for over 12%. Other injuries included broken bones and open wounds. The farm activities associated with highest injury levels included working with farm machineries and working with animals. The study concluded that farm work related injuries in Ireland contributed substantially to the burden of medical system and that the safety status of technology was strongly associated with the safety perceptions and believes of the farmer.

In Tanzania (Kayumba, et al, 2008) a research was carried out to study the prevalence of acute respiratory symptoms among sisal workers. A cross-sectional study was carried out among six of 28 actively producing sisal processing estates with each estate having a processing factory. 163 dust exposed workers in brushing and decortications departments were interviewed while security workers who were considered to have low exposure were used as a control group. A modified optimal symptoms score on respiratory symptoms and part of modified British Medical Research Council questionnaire were used for interviewing all consenting workers immediately after the work shift on the first day of the week. Workers were requested to rate the symptoms according to severity on a five – point scale. SPSS version 13 was used for analysis, t-test for comparing age, chi-square tests and Fischer's exact tests were used for analysing categorical variables. Workers in brushing department had significantly higher prevalence of dry cough, productive cough, stuffy nose, running nose and sneezing than decortications workers. The exposed group had a significantly higher prevalence of dry cough, sneezing, wheezing and shortness of breath than the control security group. The study concluded that there was high prevalence of acute respiratory symptoms among sisal production workers that might be associated with exposure to aerosol and sisal fibre dust in the processing areas.

In Korea, a study was carried out (Lee & Lim, 2008) with the aim to expound on the current status of work related injuries and diseases of Korean farmers and to provide basic data for future use. The study used secondary data from previous studies and government records to come up with the findings. According to information obtained from the national Agricultural Cooperative development, the incident rate of accidents was 40.7 cases per 1,000 person-year in 2006. Most frequent accidents were also found to be coming from use of tractors and machinery. Among the work related diseases identified includes: pesticide poisoning, peasant syndrome (stress, physical fatigue, mental tension, nutritional deficiency, infection, parasites and cold injury), vinyl house disease, respiratory diseases, musculoskeletal diseases, infectious diseases [parasitic infection, zoonosis (tsutsugamushi, hemorrhagic fever with renal syndrome, leptospirosis, anthrax, rabies, tularaemia, skin diseases, snake bites and insect bites, psychiatric diseases, green tobacco sickness, health hazards in the underground storage

facilities of ginger roots and others)]. The study concluded that, the health problems encountered by farmers in Korea constitute a major issue for one of the primary industries and should therefore be considered as an investment and should be handled by the national government.

In Poland, characterization of occupational diseases of farmers including allergic diseases, tick borne diseases and zoonoses was carried out using secondary data (Zukiewicz-Sobczak, Chmielewska-Badora, Wroblewska, & Zwolinski, Oct 2013). The study found out that the greatest risk to the health of the farmer is biological hazards in the form of numerous microorganisms and their metabolites and particles of plants and animals contained in the organic dust and pathogens transmitted by vectors. It also identified limited access to health care and lower health literacy as contributors to poor health status.

In Nigeria, a research was carried out to identify occupational diseases and illness affecting rice farmers in Afikpo North, Ebonyi state (Okereke & Okereke, 2015). The study identified the most prevalent diseases to be Malaria at 15.5%, typhoid at 12.5%, and coughs at 10%. About 24.5% of the respondents obtained medication at the hospitals while 19% relied on herbal homes, 18% on diagnostic laboratories, 16% on self-medication, 11.5% on chemists and 11% on spiritual homes. The study also noted that there was inadequacy of medical facilities.

In Turkey, a study was carried out to explore the health risks faced by agricultural workers (Cakmur, 2014). The study was carried out in Eastern Anatolia where agriculture and animal husbandly were most extensive. Data was collected through face to face interview to 177 subjects in 11 different villages in Kars province by use of a questionnaire consisting of open and closed ended questions. The study found that 23.7% of the respondents were illiterate while 11.9% were literate but having not attended any school. 40.1% had an elementary school education. 21.5% of the respondents used pesticides while 39.5% used artificial fertilizers. The study determined that biological, psychological and social health problems were relatively common and the underlying cause was the educational levels of the farm workers.

In Sweden, a comprehensive survey of injuries in Agriculture was carried out (Pinzke, Svennefelt, & Lundqvist, 2018) to update the statistics on injuries and to provide the data of the effectiveness of the intervention. There were 63,000 active farms and questionnaires were sent to 6,000 farms. Results showed that there were 4,400 injuries of which only 344 were registered with the regulatory body which amounted to only 7% of the total injuries. About 70% of the farms where injuries occurred had animals. The study found that farmers who received work environment advice and training introduced measures in place to prevent injuries than those who did not receive any. Even with all the efforts to reduce accidents in agriculture the accident level was very high compared to other industries. The study recommended safety campaigns and more permanent safety work in agriculture to raise the awareness and encourage safe behaviour.

2.4.3 Cost of injuries and ill health

A study conducted to estimate the cost of job related injuries in Agriculture in the United States of America for 1992 (Leigh, McCurdy & Schenker, 2001) data from National surveys was used to assess the incidence of fatal and non-fatal farm injuries. To assess the costs, human capital method was used that allocates cost to direct categories such as medical expenses as well as indirect categories such as lost earnings. Cost data were drawn from health care financing administration and compensation insurance. The study found out that, 841 fatalities has been recorded and 512,539 non-fatal injuries out of which 281,896 led to a one lost workday case (LWC). The cost of agricultural occupational injuries was US$4.57 billion which was 30% more than the national average. The cost of farm injuries were at par with the cost of hepatitis but that the high cost was in sharp contrast to the limited public attention and economic resources devoted to prevention of farm injuries. The study concluded that agricultural occupational injuries were an underappreciated contributor to the burden of health and medical costs in the United States of America.

In Australia a study sought to estimate the economic cost of farm-related fatalities over the period 2001 – 2004 and the perceptions and performance relating to safety culture

within their farms (Pullock, 2010). This study had two related sections; the first dealing with the economic costs while the second was a qualitative study on farmers perceptions and behaviours. A table of random numbers was used to select ten statistical local areas where questionnaires were administered. G*Power software was used to calculate the sample size and the study employed human capital approach to establish the economic costs of farm related fatalities to the Australian economy. The study found that the most perceived risk by the farmers was livestock handling and working in stockyards (n=57), silos (n=55), usage and storage of farm chemicals (n=33), general over familiarity, complacency, carelessness and human error (n=28) and working with machinery and equipment (n=27). Majority of accidents occurred in males while highest accidents occurred to the age bracket 45 – 54 years. Sprain and strains were the mostly reported followed by cuts, lacerations and fractures. Women were more cautious in their nature and hence more likely to have a positive attitude towards farm safety than men. The study concluded that farmers were overestimating the risk of agents less commonly resulting in injuries while underestimating risks of most frequent cause of death which a real problem in Australia. It also concluded that farmers related fatalities cost the Australian economy some $650.6 million in 2008 which was 2.3 % of the GDP for that year.

Another study was carried out in Australia with the purpose of updating the estimated cost of work related injury and illness for the 2005-06 financial year based on a methodology developed and applied in 2004 by the National Occupational Health and Safety Commission (Australia Safety and Compensation Council, 2009). In the first survey whose methodology was adopted (Industry Commission report No 47, 1995), a quarterly survey of Australian households was carried out as a means of estimating the level of the OSH problem in Australia. The survey targeted three populations — persons working (between 18 and under 65 years old), persons not working (between 18 and under 65 years old) and those above 65 years. A questionnaire was used for data collection in a face to face interview of adults covering the whole country. From the sample of 9209 respondents, a total of 803 work-related health problems were identified. The cost estimation methodology was based on the concept of the “human

cost" hence only costs associated with actual injury or illness were included in the cost estimate.

The following methodology was therefore applied in coming up with the estimate:-

i. Identify the major category of economic cost
ii. Determine the best source of measurement for each cost
iii. Define the levels of severity
iv. Identify the cost items that apply for each category of severity
v. Determine the number of incidents in each category
vi. Calculate the average cost of a typical incident in each severity category
vii. Calculate the total cost of all work related incidents

The cost of work related injury and diseases to workers, their employers and the community was estimated to be $ 57.5 billion in the financial year 2005-06 with injuries accounting for $38.3 billion (67%). 96% of the cost is borne by the individuals and society while the employer bears only 3%.

In the year 2012–13, work-related injury and disease cost the Australian economy $61.8 billion, representing 4.1% of GDP. The majority of the cost (95%) was borne by individuals and society. Workers bore 77%, the community 18% and employers 5% while injuries alone accounted for $28 billion (45%) of the cost (Safe Work Australia, 2018).

In Great Britain, the total cost of occupational injuries and work related diseases excluding occupational cancer were estimated to some £ 13.4 billion in 2010/2011 (HSE, 2012) workplace alone costing £ 8.2 billion. Over half of the cost was borne by the individual while the rest was shared between the government and the employers. The cost to individuals in the calculations includes loss of income; non-financial human costs; health and rehabilitation costs; administrative costs; and compensation costs. The costs to employers includes sick pay payments, insurance premiums, production disturbance costs and administrative and legal costs while the cost to the government includes reduction in tax and national insurance receipts; medical treatment and rehabilitation costs; and administrative and legal costs. In the year under

review, Agriculture, forestry and fishing economic sector, the aggregate costs to society of workplace fatalities, workplace injury and work related ill-health in 2010/11 amounted to £ 227 million.

In Mauritius, a study was carried out by collecting reports from the National Pension Fund and the occupational safety and health inspectorate in the year 2002 – 03 (ILO, 2012). Some 3,634 accidents were registered of which 14 were fatal. The total cost was estimated to be 0.05% of the country's GDP

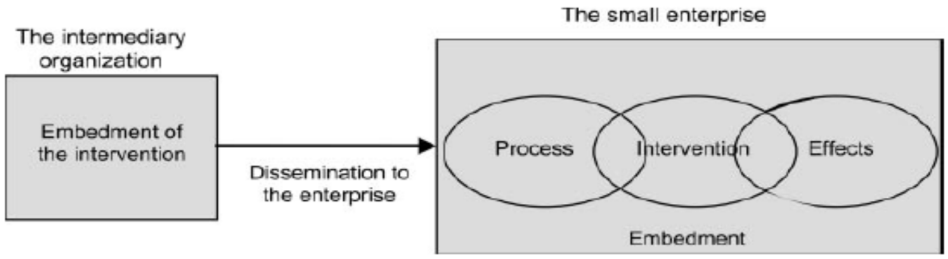
2.4.4 Intervention programs

In Thailand, a study was carried with the objective to empower farmers to study occupational safety and health situation in rice growing and to develop a model to promote their health and prevent occupational safety and health hazards from affecting them (Buranatrevedh & Sweatsriskul, 2005). Some 24 farmers were recruited from 9 villages to assist in the research that comprised of three stages. The first stage was a situational analysis for occupational related illness and accidents. The second phase was the development of the model for prevention of accidents and promotion of health while the third phase comprised measurements of knowledge, attitude and practice of the farmers after the intervention. The measurement for knowledge, attitude and practice was carried out before and after the intervention by use of a questionnaire. Knowledge was measured by use of true or false questions while attitude was measured by use of a four scale rating. Sampling was purposeful and the 24 recruited farm leaders were involved throughout the research. There were three major safety and health problems identified:

a) Symptoms from pesticide exposure
b) Musculoskeletal problems and
c) Injuries from various activities

The results of the study showed that farmers had a high level of knowledge before and after intervention but their knowledge did not reflect on their behaviour. The study also showed that participatory approach to the intervention could create a sustainable model for promoting farmers safety and health.

Hasle and Limborg (2006) have developed a model for intervention in small business enterprises where the owner is also the manager (Fig 2.2). In this model, the intervention is embedded between the process and the effects. A number of tools have been proposed for this model that includes risk assessment, different types of checklist and an action oriented type and an accident prevention program.



Source: Hasle & Limborg, (2006).

Figure 2.3: Intervention model

In Canada, a study was conducted to determine the feasibility of an education intervention for farmers in a community setting (Kim, Arrandale, Kudia, Mardell & Holness 2012). This was because farmers were at an increased risk of developing work related respiratory diseases but little was known about their occupational safety and health knowledge and exposure prevention practices. 68 farmers were interviewed by use of a questionnaire on the symptoms, occupational safety and health knowledge and exposure prevention. The study found that 60% of the farmers had received occupational safety and health training and were familiar with MSDS while 40% reported positively to knowledge of legislation and availability of MSDS. About 67% made use of respiratory protection. After intervention, there was a significant positive improvement in OSH knowledge and exposure prevention within the intervention group as opposed to the control group. This could only be attributed to the education intervention and hence intervention was therefore feasible.

The ILO has developed a programme code named WIND (Work Improvement in Neighbourhood Development) that employs a participatory action oriented training targeting small scale farmers (ILO, 2014). WIND applies the following principles:

- ✓ Builds on local practices
- ✓ Focus on achievements
- ✓ Link working and living conditions to productivity and quality
- ✓ Use learning by doing
- ✓ Encourage exchange of experience
- ✓ Promote active participation of farmers.

The use of locally adjusted training materials and facilitation by competent trainers are key to the success of the effective implementation of WIND programme.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Research design

This was a longitudinal research design since it involved repeated observations of the same variable of a crop cycle that applied a triangulation strategy to converge both quantitative and qualitative data to provide a comprehensive analysis. The information collected was a combination of both numerical and text. The text was obtained from the focus group discussions while the questionnaire generated both numeric and text.

3.2 Study area and population

3.2.1 Study area

PERKERRA

(0^0 28’ N and 36^0 01’ E)

MWEA

(0^0 42’ S and 37^0 22’ E)

AHERO

(0^0 11’ S and 34^0 55’ E)

(Source: http://www.mapsofworld.com/

Figure 3.1: Study area map

Mwea irrigation scheme in Kirinyaga County, Perkerra irrigation scheme in Baringo County and Ahero irrigation scheme in Kisumu County were selected purposefully for this study (Figure 3.1). The selection was based on the fact that the three were representative of the seven public schemes managed by the National Irrigation Board (NIB). The selection took cognisance of the different climatic conditions and a varied culture from the mountains, to the lake basin via the arid areas of Baringo. There was no information on Bura and Tana irrigation schemes since the two were not operational at the time of the study. At the lake basin, there were three schemes namely Ahero, West Kano and Bunyala. The researcher selected Ahero since it was the larger scheme among the three and more easily accessible.

3.2.1.1 Mwea Irrigation scheme

Mwea Irrigation Scheme is in Kirinyaga County, Central Kenya at the base of Mt. Kenya, about 100 kilometres North-East of Nairobi, the capital city of Kenya (Figure 3.2). The scheme occupies the lower altitude zone of the county with expansive low-lying marshy areas mainly comprising of black cotton soils. The scheme occupies the lower altitude zone of the county with expansive low-lying marshy areas mainly comprising of black cotton soils. It is in the mid-altitude range of between 1,489 and 2,000 meters above sea level with minimum a mean temperature of 20^0C to 25^0C and a mean rainfall of 950 mm (Nyabonyi, 2016). Rainfall distribution is erratic, with long rain in April/May and short rains in October/November (Kuria, Ommeh, Kabuage, Mbogo & Mutero, 2003)

The scheme has a gazetted area of 30,350 acres of which a total of 26,000 has been developed for paddy production (NIB, 2016). The scheme is used for settlement, public utilities, subsistence and commercial crops farming that includes rice, beans, tomatoes, maize and other horticultural crops. It is served by two main rivers namely Nyamindi and Thiba rivers. Irrigation water is abstracted from the rivers by gravity with the help of fixed intake weirs, conveyed and distributed in the scheme via unlined open channels. The scheme was developed on a gazetted land and the farmers were settled as tenants each with a holding of at least 4 acres based on the minimum

economic acreage sufficient for the full time upkeep of the farmers at the time. Due to the increase in the population, most of the holdings have been subdivided among family members and in other cases transferred to new farmers (NIB, 2014).

Source https:www.google.com/

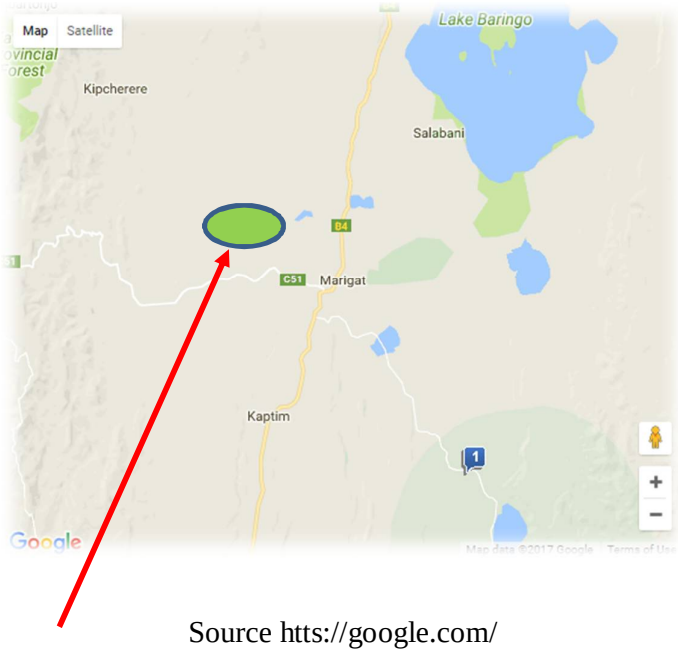
Figure 3.2: Mwea irrigation scheme location

3.2.1.2 Perkerra irrigation scheme

Perkerra Irrigation Scheme is situated 100 Kilometres North of Nakuru town near Marigat Township in Baringo County within the Rift Valley (Figure 3.3). It derived its name from the River Perkerra, which is the source of the irrigation water, and the only permanent river in the Sub-county. The construction of the Scheme started in 1954 and started operations in 1959. The Scheme lies in a semi-arid climate condition with an annual average rainfall of 630mm with great seasonal and annual fluctuations. Maximum and minimum temperatures average at 36^0C and 16^0C. The main crop in the scheme is Seed Maize under a Growing Agreement with Kenya Seed Company and other seed companies well represented.

The gazetted area was 5,850 acres out of which 2,500 acres was under irrigation where over 2 million kilograms of seed maize valued at over Ksh 100 million was produced

annually (NIB, 2016). Apart from maize seed other crops grown in the scheme includes bananas, fruits, Nerica rice and tomatoes.



Source https://google.com/

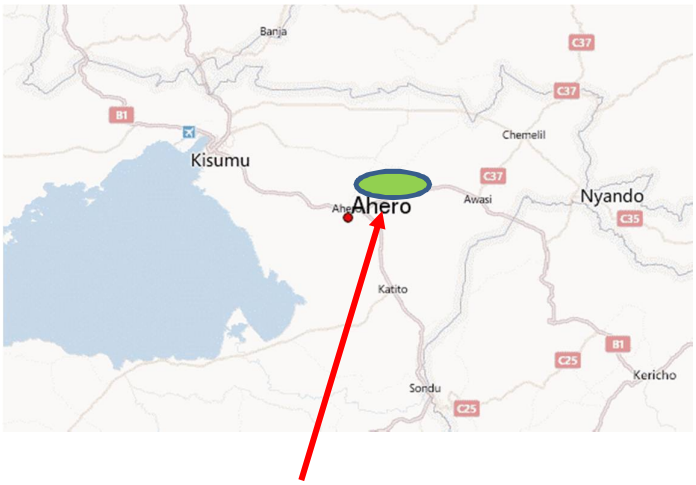
Figure 3.3: Perkerra irrigation scheme location.

3.2.1.3 Ahero Irrigation Scheme

The Ahero Irrigation Scheme is located in the Kano plains between Nandi Escarpment and Nyabondo Plateau within Kisumu County (Figure 3.4). The scheme was started as a pilot project to explore the feasibility of irrigation in the Kano Plains. Construction of the scheme started in 1966 and operations started in 1969 (NIB, 2016).

The gazetted area was 4,176 acres of which 2,586.5 acres were under irrigation. Water is drawn from river Nyando by use of pumps and conveyed by means of partially lined canals and earthen canals to the plots. The type of irrigation used is basin/flood irrigation

The main crop grown at Ahero irrigation scheme was rice. Other crops included Soybeans (seed and commercial), Watermelon, Maize, Tomatoes, Sorghum and Cowpeas.



Source https://www.google.com/

Figure 3.4: Location of Ahero irrigation scheme

3.2.2 Study population

The total population of plot holders in all the public irrigation schemes in Kenya was 21,561 plot holders (KNBS, 2014) while the population of plot holders in the study area comprised of 7,178 from Mwea, 946 from Ahero and 1,221 from Perkerra. For the purpose of this study, the family heads in each plot was considered to be the farm worker and therefore formed part of the study population. The other respondents included the in charge of the health care facilities and agricultural officers responsible for Mwea, Muhoroni and Marigat who has responsibility over the irrigation schemes.

3.3 Sample size determination

When the population elements are highly homogeneous, samples are highly representative. The larger the sample the more accurate the research is likely to be while the smaller the sample, the bigger the sampling error (Mugenda and Mugenda, 2003). In calculating the sample for this study, the following formula (Cochran, 1963) as cited by Israel, (1992) (revised 2009 and reviewed 2012) was used:-

$$n_o = \frac{Z^2 pq}{e^2}$$

Where n_o = the desired sample size

Z = 95% confidence level corresponding to statistical value of 1.96)

p = the proportion in the target population estimated to have characteristics being measured = 0.5

q = 1 – p

e = desired level of precision = $\pm$0.5%

$$= \frac{1.96^2 \times 0.5 \times 0.5}{0.5^2}$$

= 384 farmers

A total of 380 farmers were therefore sampled and distributed proportionately as shown in Table 3.1. The proportions were based on the population of plot holders in each irrigation scheme and the number of plot holders in each scheme/block as shown in Table 3.2. A total of 14 HCPs were targeted that comprised of 4 in Ahero, 3 in Perkerra and 7 in Mwea.

Table 3.1: Sample distribution in the irrigation schemes

Scheme	Population	Sample size	% of sample	HCP
Mwea	7,178	293	77	7
Perkerra	1,221	49	13	3
Ahero	946	38	10	4
Total	9,345	380	100	14

Table 3.2: Distribution of respondents in the schemes

Irrigation Scheme	Blocks	No of Villages in the Block	Questionnaires
Ahero	-	7	38
Perkerra	-	7	49
Mwea	Mwea	10	70
	Tebere	11	77
	Thiba	8	56
	Wamumu	8	56
	Karaba	5	34
Total Respondents			**380**

3.4 Inclusive and exclusive criteria

All plot holders in the three schemes, present in their farms at the time of data collection formed part of the study population. HCP incharge and Agricultural extension officer on duty at the time of data collection also formed part of the study population.

All persons present at the irrigation scheme but did not own or had not rented a plot for cultivation were excluded from the study population.

3.5 Sampling method and procedure

A two stage sampling was used. Purposeful sampling was used in selecting the three irrigation schemes as explained in section 3.2.1 while stratified random sampling was used in selecting the respondents with the irrigation schemes forming the strata.

The study was conducted in four stages: observation survey using a checklist; cross-sectional survey using a structured interview; a workshop with focus group discussion teams; and an intervention stage. In each irrigation scheme the research assistants were trained to understand the contents of the questionnaire and how to handle respondents

who were not proficient in English language. Data was collected from March 2016 to Jan 2017 with the focus group discussion meetings being conducted from March 2017 to July 2017. The intervention followed in Mwea irrigation scheme from August 2017 to April 2018.

3.5.1 Observation survey

The observation survey was a field observation to scrutinize the type of hazards present in each production stage. A guide to hazard observation was by means of a checklist (Appendix 5) that addressed all stages of farm work from land preparation to harvesting which meant regular visits to the farms at intervals. Photographs were taken as evidence of the identified hazards and have been presented as plates in chapter 4 of this report. There was no sampling here as observations covered the whole scheme.

3.5.2 Cross-sectional survey

This stage comprised of data collection from three different informants namely the farm worker, the HCP in-charge and the agricultural officers. Farmworkers did not report to the farms at the same time and since data collection was conducted throughout the day, all farm workers had the chance to become respondents. Simple random sampling was applied to select the farm workers from among those present in their plots at the time of data collection in all the villages within the irrigation schemes. Ahero and Perkerra irrigation schemes had seven villages each while Mwea had 42 villages clustered in 5 blocks each having between 5 and 11 villages each.

The farmworkers indicated the HCP where they received medical services during the interview and hence these HCPs became part of the respondents as was the case of the Agricultural officers who were on duty at the irrigation schemes during the period of data collection.

3.5.3 Focus group discussions

A half day workshop was held in each of the three irrigation schemes with the FGD teams. Two FGD meetings were held in Ahero, two FGD in Perkerra and 4 FGD in Mwea. The meetings focused on issues that emanated from both the observation and cross sectional survey to seek clarification and reasons for some occurrences which included community beliefs, their practices and knowledge. The discussions were moderated by the researcher for the group to freely discuss the topics selected and were recorded by use of a voice recorder for ease of review and interpretation where necessary. The selection of the groups was done purposefully through consultation with IWUA leaders to have many members who can speak in either English or Kiswahili for ease of understanding by the researcher and his assistants and to improve the quality of the discussion.

3.5.4 Intervention stage

This stage involved development of control measures through a risk assessment process that were necessary to reduce the impact and occurrences of injuries and ill health within Mwea irrigation scheme (Mwea block) after analysis of the initial study. Some 40 farm workers were randomly recruited and intervention measures explained to them in form of group training and practicing on the farm for one crop cycle (demonstrations). Training meetings were held with the participants in which job risk assessment of a particular stage of the crop cycle were discussed by the team members and control measures developed and agreed upon. The participants were visited severally by the researcher in their farms to assess the uptake of the intervention and assist where challenges were encountered. Moreover, at the end of the crop cycle, the participants were interviewed face to face to assess their understanding of safety and health issues (Appendix 6).

3.6 Research instruments

In achieving the specific objectives, a checklist was prepared to collect data of the hazards that were observed. A detailed structured interview-questionnaire was

administered to get information from the farm workers on a variety of issues including demographic factors based on all the specific objectives. This included such issues as tools and equipment used; types of chemicals and their handling; crops produced and environmental conditions; constrains encountered in applying good practice; personal believes and trainings attended if any for purposes of increasing knowledge in farm work and self-protection. Other information collected from the farm workers included whether they had been victims of injuries and ill health associated with their work and their sources (Appendix 2). A pilot survey was carried out at the lower Thika river basin to test the effectiveness of the interview-questionnaire on independent small scale irrigation farmers. The instrument was found to be effective with minor adjustments.

Another questionnaire was prepared and administered to the local HCPs to collect data on recorded cases of injuries and ill-health (Appendix 3). The local Agricultural officers also filled questionnaires to give information on types of training offered, list of approved chemicals and any other issue that was deemed necessary for the completion of this study (Appendix 4).

A voice recorder was used for speech recording during the focus group meetings, and a camera for taking still photos for purposes keeping records of observations and to help in reviewing and interpretation where necessary of discussions for ease of understanding by the researcher.

3.7 Ethical considerations

The research involved application of a questionnaire to farm workers and requesting them to provide information on their safety and health issues. The participants were informed of the objectives of the research and their rights through an informed consent for them to decide to participate or not. The participants were not required to indicate their names on the questionnaire and hence whatever answers they gave remained anonymous. The information given was not shared with other participants and therefore remain confidential (Appendix 1).

The study also involved observation of practices but privacy, cultural values and psychological wellbeing were respected. Confidentiality was observed in all levels of the research. The research was approved by JKUAT (Appendix 7) and an introduction letter issued by IEET (Appendix 8). Ethical approval was sought and granted by Kenyatta University ethics review committee before commencement of the research process (Appendix 9).

The participants were informed of the outcome of the research during the focus group discussions and also during the intervention period. Training was carried out on good practices to reduce impacts of contact between the farm workers and the hazards identified in the study and other issues that were noted by the researcher or his trained assistants and recorded.

3.8 Data analysis

The data collected was sorted, edited coded and analysed using SPSS ver. 20 and presented in descriptive statistics. Statistical tests for correlation was carried out using Chi Square tests and the results presented using charts and tables. The economic loss was calculated using the Human cost method as was carried out by previous researchers (Pullock, 2010) (Australia Safety and Compensation Council, 2009) except for data collection which in this study was primary data as opposed to secondary data that was used in the previous cases.

In the constraint to good OSH practice section, the Likert scale used was as follows:-

1. Strongly agree = 1
2. Agree = 2
3. Neither agree nor disagree = 3
4. Disagree = 4
5. Seriously disagree = 5

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Response rate

A total of 380 interviews were planned and executed in the three irrigation schemes as follows; 38 in Ahero, 49 in Perkerra and 293 in Mwea. All respondents accepted to participate in the interview. This was a response rate of 100% which can be described as excellent. Health data was collated from 13 HCPs, 4 from Ahero; 6 from Mwea; and 3 from Perkerra schemes. Questionnaires were also completed by a total of 9 agricultural officers working closely with the farm workers at the irrigation schemes, 4 from Ahero, 3 from Mwea and 2 from Perkerra. In addition, observations were gathered and compiled by the researcher using a guided checklists. The high rate of respondents can be attributed to the presence of the researcher throughout the data collection period and the influence of the Irrigation Water Users Association (IWUA) chairmen in all the three schemes. All questionnaires were completed in the presence of either the researcher or his research assistants who had received adequate training on the tool.

During the FGDs, 20 farm workers were invited in the Ahero scheme but only 17 attended; in Perkerra similarly 20 farm workers were invited but only 16 attended while in Mwea 40 farm workers were invited and all of them attended the workshop. At Ahero and Perkerra two FGD meetings were held in each scheme with attendance of about 8 and 9 in Ahero; and 9 and 7 in Perkerra. In Mwea, 4 FGD meetings were held each with 10 participants.

At the intervention stage in Mwea irrigation scheme, 40 farm workers were trained by the researcher and his assistants and on completion, 40 interviews were administered successfully. Plate 1 (a) and (b) shows the researcher and his assistant conducting the interview to an agricultural officer and farm worker respectively.

Plate 4.1(a) and (b): Interviewing the Agricultural officer (Ahero), and farm worker (Perkerra)

4.2 Characteristics of the respondents

Majority of the farm workers in all the three irrigation schemes were male reported as follows: - 60.5% in Ahero, 71.4% in Perkerra and 57.3% in Mwea. The study targeted household heads who were in most homes men. Majority of the respondents (71%) were aged above 46 years in Ahero, while Perkerra had 32.7% and Mwea 39.6% for the same age group. Perkerra irrigation scheme had youthful farm workers totalling 48.9% followed by Mwea at 33.4% and Ahero, 7.9%: the group being below 35 years of age which is referred to as youthful age in Kenya. The solution for youth employment defines youth as individuals between 15 – 29 years (ILO, 2017) while the UN defines youth as those persons between ages 15 and 24 years (www.unesco.org/..)

On education, 50% of the respondents in Ahero had secondary school education and above compared with Perkerra with 44.9% and Mwea 38.2% for the same level. Farm workers with secondary education were expected to understand the implications of exposure to hazards better than those with primary school and below. The respondents in Ahero were therefore better educated compared to the other schemes with Mwea trailing the other two. Table 4.1 gives the detailed characteristics of the irrigation scheme respondents.

Table 4.1: Characteristics of the respondents

Variable		Ahero % N = 38	Perkerra % N = 49	Mwea % N = 293
Gender	Male	60.5	71.4	57.3
	Female	39.5	28.6	42.7
Age (years)	< 20	0	2	1
	21 – 35	7.9	46.9	32.4
	36 – 45	21.1	18.4	27
	46 – 60	60.5	28.6	24.6
	Above 60	10.5	4.1	15
Education	None	10.5	12.2	3.8
	Primary	39.5	42.9	58
	Secondary	36.8	36.7	34.5
	Tertiary	13.2	4.1	3.4
	University	0	4.1	0.3
Length of farm working (years)	< 5	10.5	12.2	19.8
	5 – 10	13.2	34.7	22.9
	11 – 19	36.8	22.4	13.3
	20 - 30	21.1	24.5	20.1
	Above 30	18.4	6.1	23.9
Farm size (acres)	< 1	23.7	28.6	30.7
	1 - 4	71.1	65.3	63.4
	Above 4	5.3	6.1	5.9
Average annual income Ksh	< 60,000	36.8	44.9	18.4
	61,000 –120,000	47.4	40.8	50.9
	121,000 – 360,000	13.2	14.3	20.8
	361,000 – 600,000	2.6	0	5.5
	Above 600,000	0	0	3.4

Ahero respondents had a mean age of 43 years, Mwea 38 years and Perkerra 33 years. Ahero also had respondents with the highest length of farm working with a mean of 13 years, followed by Mwea with 11.5 years and Perkerra with 9 years. Majority in all

the three schemes had farm sizes of between 1 and 4 acres. The government allocated each plot holder 4 acres of land at the start of the schemes but the land has since been sub-divided into smaller units to cater for the children (NIB, 2016).

Out of these farms, about 36.8% of the farmworkers in Ahero, 44.9% in Perkerra and 18.4% in Mwea had an income of below Ksh 60,000.00 per annum translating to below Ksh 5,000.00 per month. This was far below the GDP per capita income in Kenya of Ksh 94,757.00 in 2016 when data was collected and Ksh 96,800 for 2017 that translated to Ksh 7,896.00 and Ksh 8,067 per month respectively (KNBS, 2017; KNBS, 2018). Only 2.6% of the farm workers in Ahero and 8.9% of farmers in Mwea earned above Ksh 360,000.00 per annum (Ksh 30,000 per month) while none in Perkerra was in that level. Mwea had the highest mean earnings of Ksh 75,160 per annum with Ahero farm workers earning Ksh 49,200 and Perkerra at Ksh 41,400 per annum. From the results presented, it can be inferred that Ahero irrigation scheme had the oldest farm workers, with the longest farm working but low earnings, while Perkerra scheme had the youngest farm workers with the least experience and earning the least income. Mwea on the other hand had a middle aged farm workers with medium length of farm working but earning the highest income.

4.3 The OSH hazards for irrigation farm workers

Irrigation farm workers in the three schemes were exposed to a number of occupational hazards which were classified in their broad categories as chemical, biological, physical and ergonomic hazards.

Analysis of the exposure to hazards showed that in Ahero irrigation scheme, biological hazard exposure was 28.8%, ergonomic hazard exposure was 26.3%, physical hazard exposure was 24.0% and chemical exposure was 20.9% as shown in the Figure 4.1. Mwea scheme recorded biological hazards of 28.3%, ergonomic hazard exposure of 21.2%, physical hazard exposure of 28.5% and chemical hazard exposure of 22.1% while Perkerra scheme recorded Biological hazard exposure of 29.1%, ergonomic hazards exposure of 24.9%, physical hazard exposure of 24.3% and chemical hazard exposure of 21.7%.

Ahero had the highest exposure to ergonomic hazards due to manual operations like carrying heavy loads compared to Mwea which had the highest exposure levels to physical hazards due to the presence of machinery. Chemical hazards exposure were moderate in all the schemes with Mwea leading at 22.1% followed by Perkerra's 21.7% and Ahero 20.9%. All the irrigation schemes had high and almost equal exposures to biological hazards. This results corroborates with the study in Poland (Zukiewicz-Sobczak, Chmielewska-Badora, Wroblewska, & Zwolinski, Oct 2013) which identified biological hazards as the greatest risk to farmer's health.

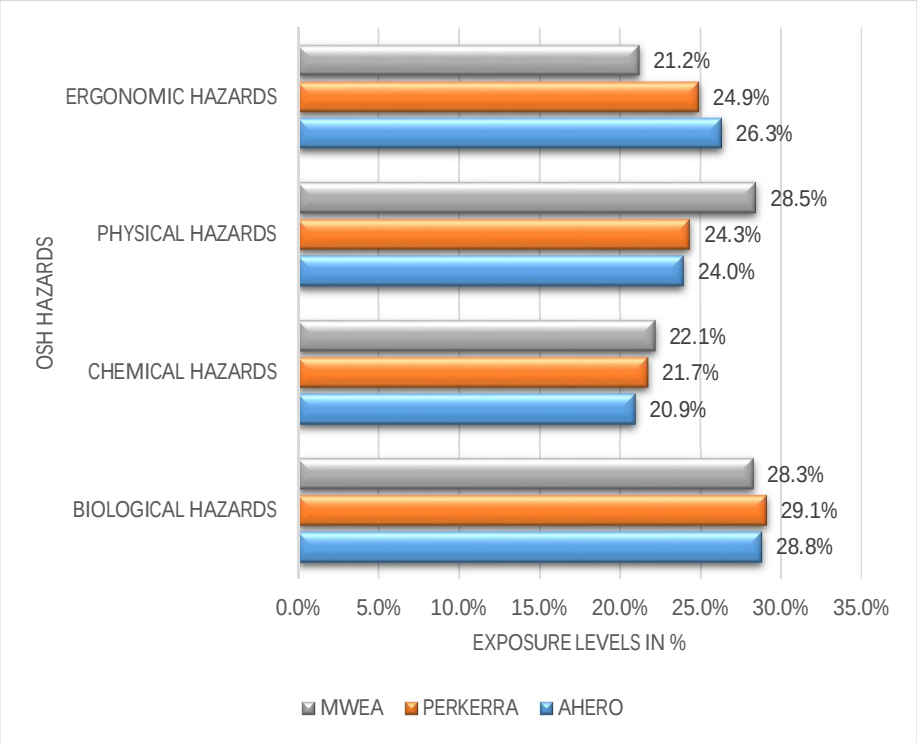


Figure 4.1: Occupational hazards exposure levels in the three schemes

4.3.1 Chemical hazards

Farm workers were at risk of chemical hazards arising from spraying of agrochemicals. When asked whether they spray agrochemicals, 97.4% of the respondents from Ahero, 91.8% from Perkerra and 81.2% from Mwea reported in the affirmative. The agrochemicals were classified in three distinct groups ie pesticides, herbicides and

fungicides. The Figures 4.4 (a), (b) and (c) show the types of pesticides used in Ahero, Perkerra and Mwea respectively.

4.3.1.1 Pesticides

Tata Umeme and Colt were the more commonly used pesticides at Ahero scheme with the usage of 39.5% for Tata Umeme and 31.6% for Colt. Other pesticides in use included Titan at 10.5%, Robust at 7.9%, and Duduthrin at 2.6%. Some 2.6% of the respondents reported that they used pesticides but they could not remember their names while 5.3% did not know whether they used pesticides or other agrochemicals (herbicides or fungicides) (Fig 4.2 a). Those who did not know indicated that they bought chemicals in small quantities from retailers without original packages.

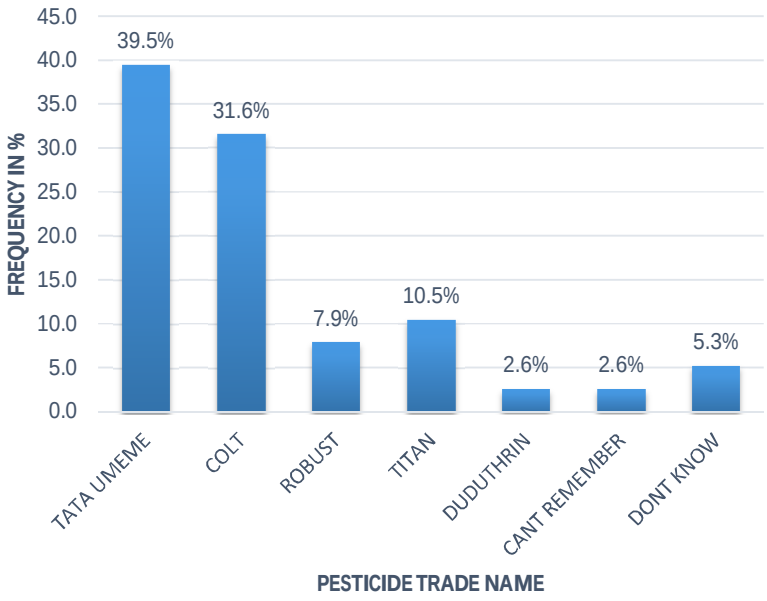


Figure 4.2 (a): Pesticides used at Ahero scheme

Tata Umeme and Colt are both registered by the pest control products board (PCPB) in Kenya as insecticides (PCPB, 2018). The active ingredients for these insecticides are Lambda – Cyahalothrin for Tata Umeme, and Chlorpyrifos for Colt. The information available from the material safety data sheets (msds) indicates that

Chlorpyrifos is an organophosphate. It affects the nervous system of people with the effect lasting for days or even weeks. Exposure to small amounts may cause running nose, tears, increased saliva, sweating, headache, nausea and dizziness while serious exposures can cause vomiting, abdominal muscle clamps, tremors body weakness and loss of coordination. Severe exposures may lead to unconsciousness, loss of bladder control and difficulty in breathing (Christensen, Harper, Luukinen, Buhl, & Stone, 2010). Lambda-Cyahalothrin belongs to a group of chemicals called pyrethroids which are manmade chemicals similar to the natural insecticides pyrethrins. It may cause irritation to the skin, throat, nose, and other body parts if exposed. Other symptoms may include dizziness, headache, nausea, lack of appetite, and fatigue (NPIC, 2001). The chemical is not classifiable as carcinogenic to humans (Environmental Protection Agency, 2017).

The commonly used pesticides at Perkerra were Thunder 33.3% and Cyclone 26.7%. Some 15.6% of the respondents could not remember the name of the pesticide that they used (Fig 4.2 b). Thunder and Cyclone were both registered by the pest control products board of Kenya as insecticides. The active ingredient in thunder is imidacloprid while in cyclone it is cypermethrin and Chlorpyrifos (PCPB, 2018). Thunder is classified as WHO class 11, with imidacloprid being moderately toxic when ingested, variable in toxicity when inhaled and very low toxic via dermal exposure (Gervais, Luukinen, Buhl, & Stone, 2010). Cyclone (cypermethrin and Chlorpyrifos) is a mixture of pyrethroid and organophosphate unlike Lambda-cyahalothrin above. Users of this chemical sometimes develop tingling, burning and itching symptoms and is unlikely to accumulate in the body. It is however classified as possible human carcinogenic (National Pesticide Telecommunications Network, 1998) (Environmental Protection Agency, 2017).

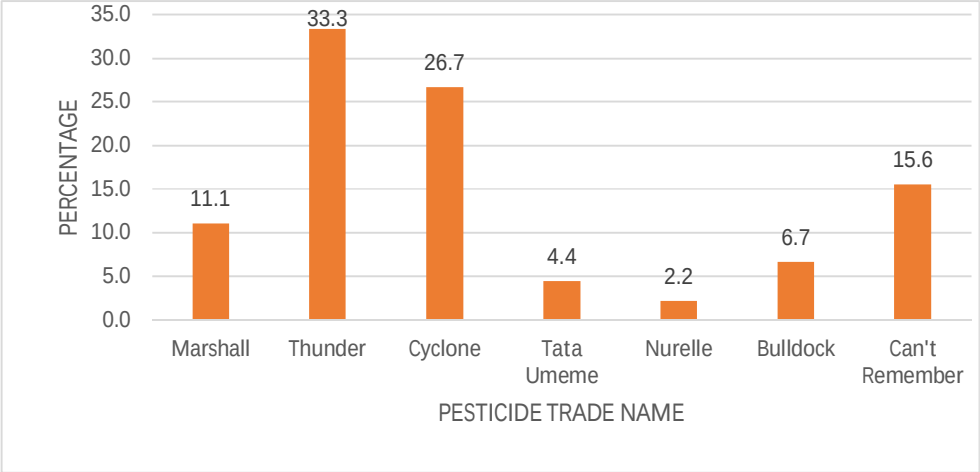


Figure 4.2 (b): Pesticides used at Perkerra irrigation scheme

In Mwea, Sumithion and Alpha were the pesticides that were used widely with 49.5% and 40.3% respectively. All the respondents were aware of the pesticides by name which was commendable as shown in Figure 4.2 (c).

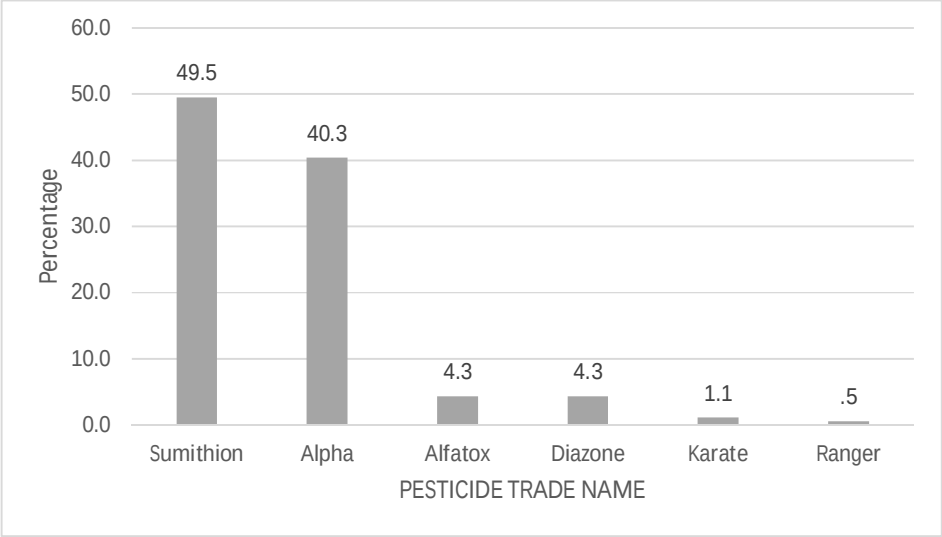


Figure 4.2 (c): Pesticides used in Mwea

Sumithion (Chemical name is Fenitrothion) is an organophosphate just like Colt above and is used as for controlling chewing and sucking insects on rice, fruits, vegetables,

and cereals. This is class 11 poison that may be absorbed through the skin, ingestion or through inhalation and is reported to cause irritation to the skin, respiratory system failure, serious eye irritation, and suspected of causing cancer. It may cause effects on the nervous system that may result in convulsions, and death (IPCS, 2017). Alpha 10 EC on the other hand is a synthetic pyrethroid. It may cause irritation to the skin, throat, nose, and other body parts if exposed. Other symptoms may include dizziness, headache, nausea, lack of appetite, and fatigue (NPIC, 2001). Alpha 10 EC is not classifiable as carcinogenic to humans (Environmental Protection Agency, 2017).

The sale of pesticides in small quantities without original packages as reported by 5.3% of respondents from Ahero scheme (Fig 4.2 a) presents a great challenge to the management of chemical poisoning. A Chi Square test showed that there was no relationship between the choice of a pesticide and the level of education. However, it was observed from the cross-tabulation of education with choice of pesticide (Appendix 11) that those who did not know the pesticide they used and those who could not remember in Ahero had either never gone to school or were of primary school level. A summary of the key pesticides in use in all the three schemes is summarised in table 4.2.

Table 4.2: Main pesticides in use at the irrigation schemes

Irrigation scheme	Chemical Trade name	Active ingredients	Chemical group
Ahero	Tata Umeme	Lambda-Cyhalothrin	Pyrethroid
Ahero	Colt	Chloryrifos	Organophosphate
Perkerra	Thunder	Imidacloprid	Neonicotinoid
Perkerra	Cyclone	Cypermethrin	Pyrethroid
Mwea	Smithion	Fenitrothion	Organophosphate
Mwea	Alpha	Cypermethrin	Pyrethroid

From the Table 4.2, there were three types of chemical groups that were in use at the irrigation schemes ie Organophosphates, Pyrethroids and Neonicotinoid.

Organophosphate can cause acute nervous system dysfunction, muscle weakness, seizures, coma, and respiratory failure. Symptoms include increased saliva and tear production, diarrhoea, vomiting, sweating, muscle tremors, and confusion [NPIC, 2001; EPA, 2017] [PCPB, 2017]. Pyrethroids have relatively low toxicity, when compared to organophosphate insecticides. However ingestion of concentrated pyrethroid-containing products can cause severe, and occasionally fatal, effects. Neonicotinoids are low toxicity to mammals and humans in comparison with traditional insecticides. Some studies show exposure to neonicotinoids pose potential risk to mammals and even humans.

4.3.1.2 Fungicides

Fungicides were widely used by the respondents in Ahero and Mwea. In Ahero, Zyban and Pearl were the widely used fungicides at 32.4% and 24.3% respectively. Surprisingly 21.6% of the respondents used fungicides but could not remember them by name while 8.1% do not know whether the chemicals they used were fungicides or any other as shown in Figure 4.3 (a). Other fungicides in use included Topsin and Sulcop at 5.4% each and Mistress at 2.7%. Those who could not remember the fungicides by name or did not know had gone to primary school level and others to secondary. As mentioned in section 4.3.1.1.above, the sale of agrochemicals in small quantities in remains a thread to the handling and use of these chemicals.

The active ingredient in Pearl 500 SC is carbendazim, which is a systemic broad-spectrum fungicide, controlling a wide range of pathogens. It is also used as a preservative in paint, textile, paper-making and leather industry, as well as a preservative of fruits. Its exposure was associated with impaired liver function, altered enzyme activity and changes in haematopoiesis and reproduction in various mammals (Veerappan, Hwang, & Pandurangan, 2012). Carbendazim is a possible human carcinogen (Environmental Protection Agency, 2017).

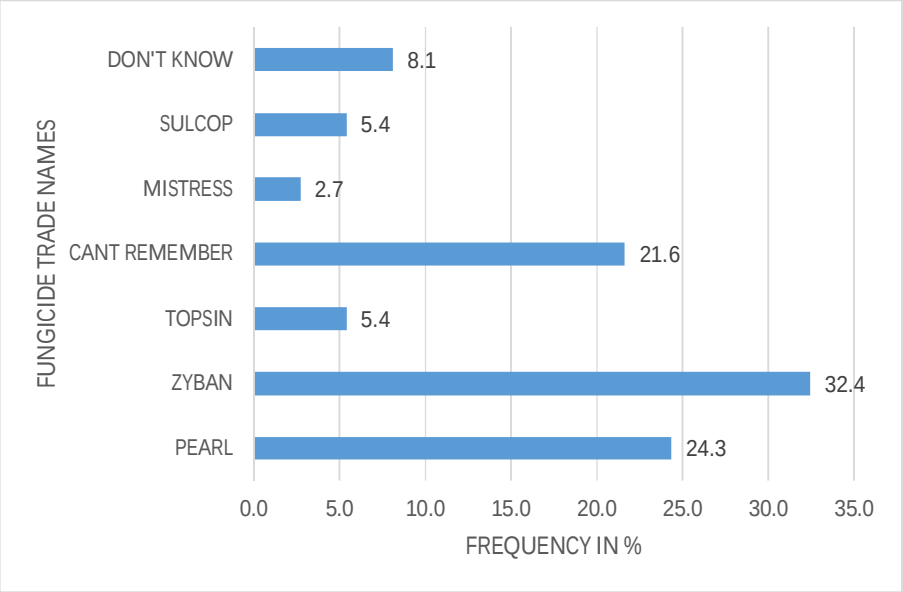


Figure 4.3 (a): Fungicides used at Ahero

Zyban has two active ingredients namely Thiophanate - methyl and Mancozeb. The potential health effects as given in the msds include may cause eye and skin, irritation, harmful if swallowed and prolonged inhalation may cause respiratory tract irritation. Thiophanate – methyl is classified as likely to be carcinogenic to humans by the US Environmental protection agency while Mancozeb is classified as probable carcinogenic.

In Perkerra, there was very low usage of fungicides due to the nature of the crops grown there. 55.6% of those who used fungicides chose Rindomill while 16.7% chose to use Mistress and another 11.1% chose ivory. Surprisingly 11.1% of the farm workers knew they were using fungicides but could not remember the name. Other fungicides in use included Tata master 5.6%% as indicated in Figure 4.3 (b).

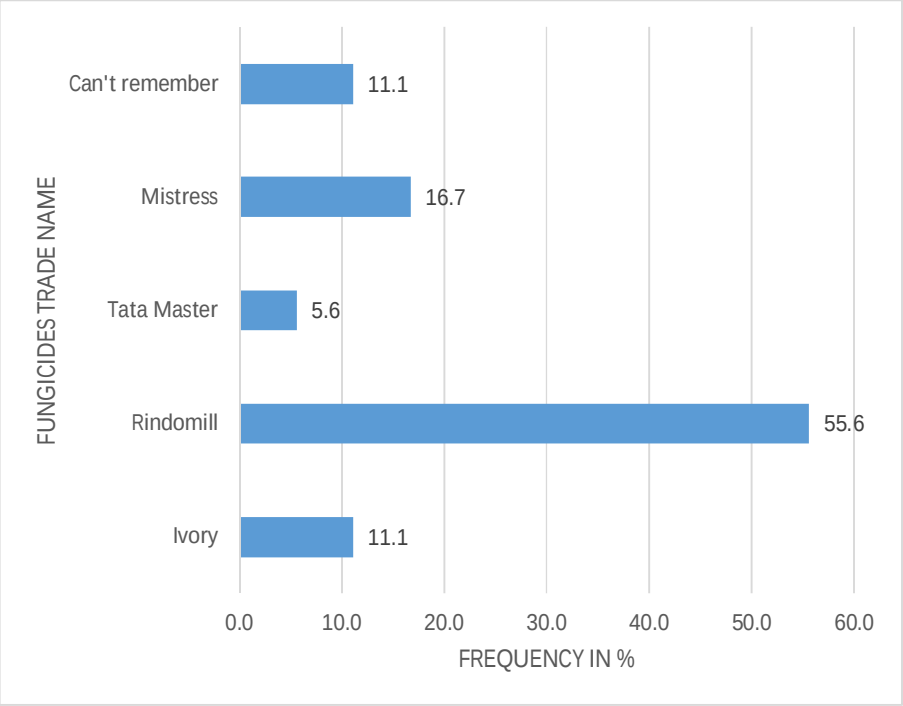


Figure 4.3 (b): Fungicides used at Perkerra

The active ingredients for Ridomil are Metalaxyl and Mancozeb. Whereas Metalaxyl is non carcinogenic for humans, Mancozeb is probable carcinogenic (Environmental Protection Agency, 2017).

In Mwea irrigation scheme, there were three fungicides in use namely Pearl at 50%, Milraz and Wetsuf at 25% each as indicated in Figure 4.3 (c). All the respondents knew the fungicides by their trade name. Milraz has two active ingredients namely Propineb and Cymoxanil. Propineb is reported to be harmful when in contact with the skin and may cause allergic skin reactions, it may damage organs through prolonged or repeated exposure (NCBI, n.d.).It is classified as likely carcinogenic to humans. Cymoxanil has similar characteristics as Propineb and has the potential of damaging fertility or the unborn child however it is not likely to be carcinogenic (Environmental protection Agency, 2017)

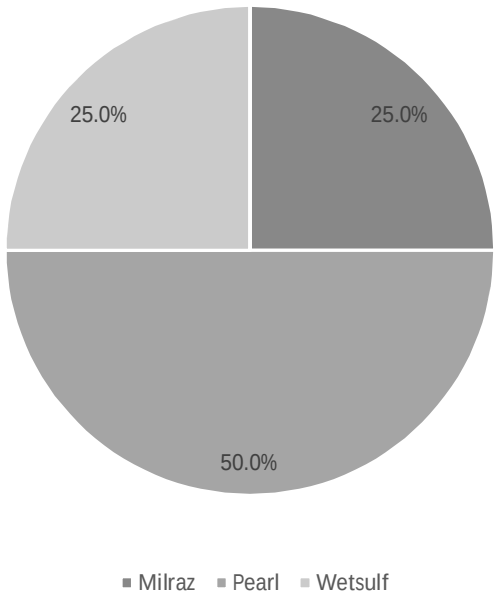


Figure 4.3 (c): Fungicides used at Mwea irrigation scheme

4.3.1.3 Herbicides

Herbicides were in use in all the three irrigation schemes but the usage in Ahero was lower than the other two schemes. Majority of those who used herbicides in Ahero (46.2%) chose to use Agrimine. 15.4% chose roundup and platform turbo while 7.7% chose Sanaphen. However another 15.4% of the respondents in Ahero could not remember the herbicides by name though they used them as shown in Figure 4.4 (a).

The information available (PCPB, 2018) indicated that Agrimine was a registered product in Kenya to be used as a herbicide. Its usage can cause skin irritation and in some cases allergic skin reactions. When inhaled, it can cause headaches, dizziness and even respiratory and eye irritation. The active ingredient in Agrimine (PCPB, 2018) is 2.4 Amine. Information from the msds indicate that the product has moderate to high acute oral toxicity. It has low dermal and inhalation toxicity.

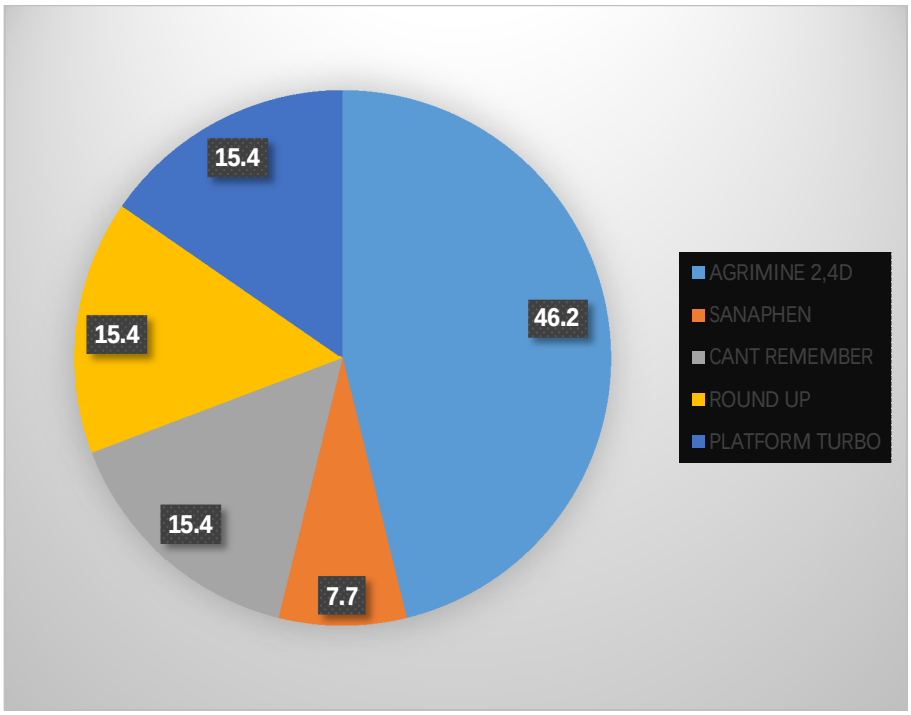


Figure 4.4 (a): Herbicides in use at Ahero

There was high usage of herbicides at Perkerra (Fig 4.4 b) with 76% of the respondents reporting that they used Maguguma and 3% each for Roundup, Agrimine and Primagram. However, 15 % of the respondents used herbicides but they could not remember them by name.

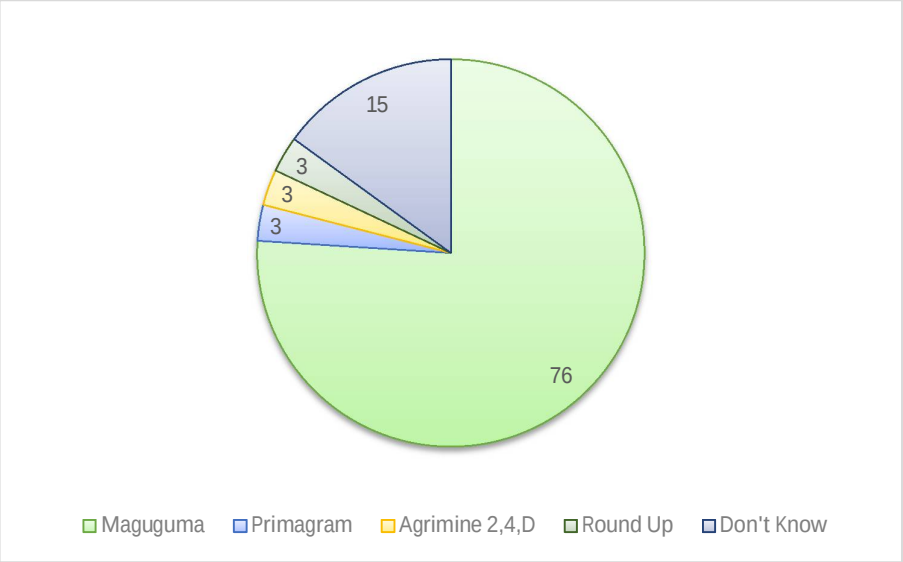


Figure 4.4 (b): Herbicides in use at Perkerra

In the focus group discussion, when asked about the method used in the choice of the herbicides they used, the respondents reported that Maguguma was readily available in the Agro vet shops as opposed to the other herbicides and was effective in the control of weed. This information suggested that the agricultural extension officers play no part in the farmer's selection of chemicals to use in the farm but rather driven by chemical marketing companies.

In Mwea (Fig 4.4 c) unlike Perkerra there was a wide variety of herbicides that were in use. These included Dicopur 35.4%, Weedal 18.3%, Touch down 17.7%, Glycel 13.7% and Herberkill 8.0%. Others are Kalach 2.9%, Novisate 1.7%, Kickout and Tingatinga 1.1% each.

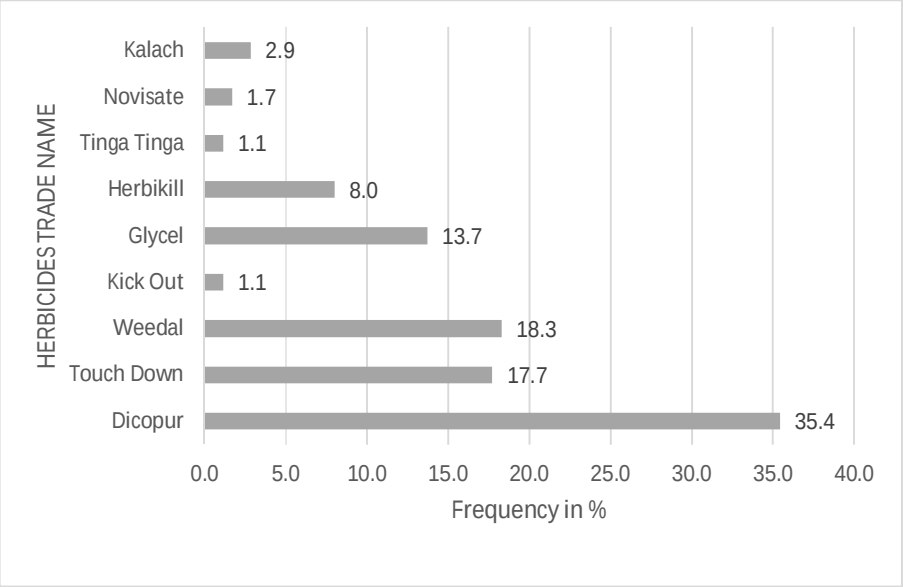


Figure 4.4 (c): Herbicides in use at Mwea

Observations in all the three irrigation schemes showed that there were no special precautions taken to minimize exposure of chemicals to the body as some workers carried out the spraying without shirts, wearing short trousers and without shoes thereby exposing the larger part of the body. This was very common in Ahero and Perkerra where they attributed the practice to the scorching sun and intense heat. The results differ sharply with the study conducted in Mitunguu, Kenya (Mburu, 2006) where the level of understanding that chemical poisoning was preventable was high (92%) and 99.4% were aware of the impact of pesticide poisoning on human health due to training programs organised by the tobacco growing sponsors. Similarly 84.0% for the study in Turkey were aware of the health impacts of pesticides despite lack of training (Oztas, Kurt, Koc, Akbaba, & Ilter, 2018). It was disheartening also to learn that some farm workers actually tasted the chemicals to determine their potency after mixing. This information came from the FGD in all the three schemes when the farm workers discussed the methods of mixing the agrochemicals and their effectiveness in the protection of their crops.

Chemical hazards were also present in the farms due to a dusty working environment (Fig 4.5). When asked whether their work involved working in a dusty environment,

97.4% of the respondents in Ahero agreed that their work environment was indeed dusty. The types of dust they were exposed to included soil dust 71.1%, pollen dust 31.6%, and manure dust 10.5%, rice husks dust 36.8% and chemical dust at 5.3%.

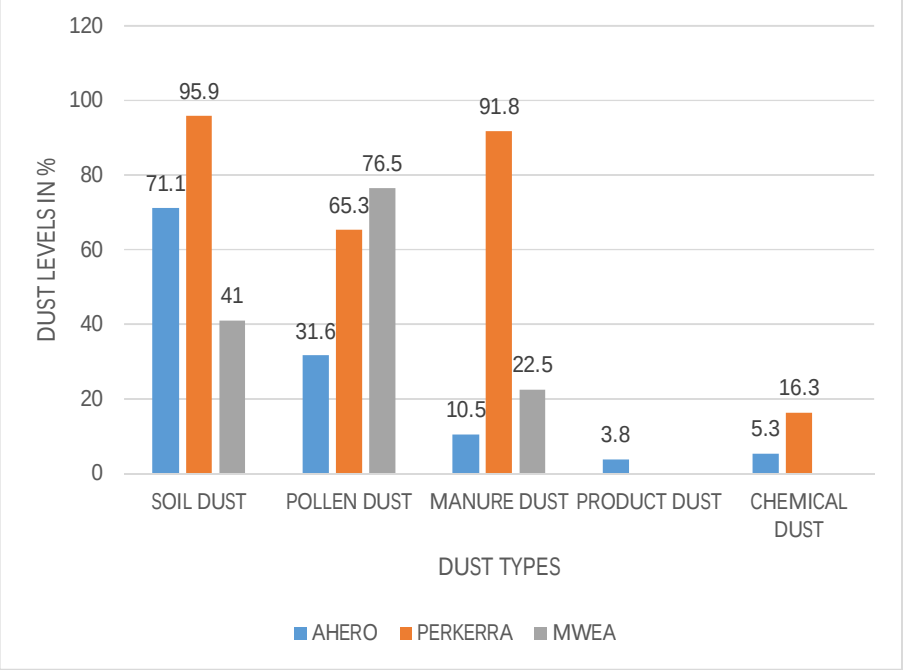


Figure 4.5: Types and level of dust exposures

In Perkerra, 98% of the respondents reported that they worked in a dusty environment with 95.9% indicating soil dust, 65.3% reporting pollen dust, 91.8% reporting manure dust and 16.3% reporting chemical dust. In Mwea, 86.3% indicated that their work environment was dusty with exposure to soil dust at 41%, pollen dust at 76.5%, and manure dust at 22.5%.

These dusts constituted both chemical and biological hazards and the respondents were free to indicate more than one type of dust if applicable to their work environment.

4.3.2 Biological hazards

Biological hazards in the farms arise when exposed to fungi/moulds, insect bites, animal waste, bacteria and virus. When asked to indicate whether they were likely to

be bitten by animals/insects, 89.5% in Ahero reported in the affirmative while 10.5% reported that they were unlikely to be bitten. 50% of the respondents reported that they were likely to be bitten by mosquitoes, 78.9% by leech, 31.6% by snakes and 23.7% by different types of flies. When further probed into how may have ever been bitten by a snake, 10.5% reported positively.

In Perkerra, 91.8% of the respondents reported that they were likely to be bitten by animals/insects with mosquito bites leading at 57.1% followed by snakes at 42.9% and bees at 30.6% while in Mwea 95.2% reported in the affirmative with scorpions at 69.3% followed by leech at 33.4% and mosquitoes at 15% as indicated in Figure 4.6.

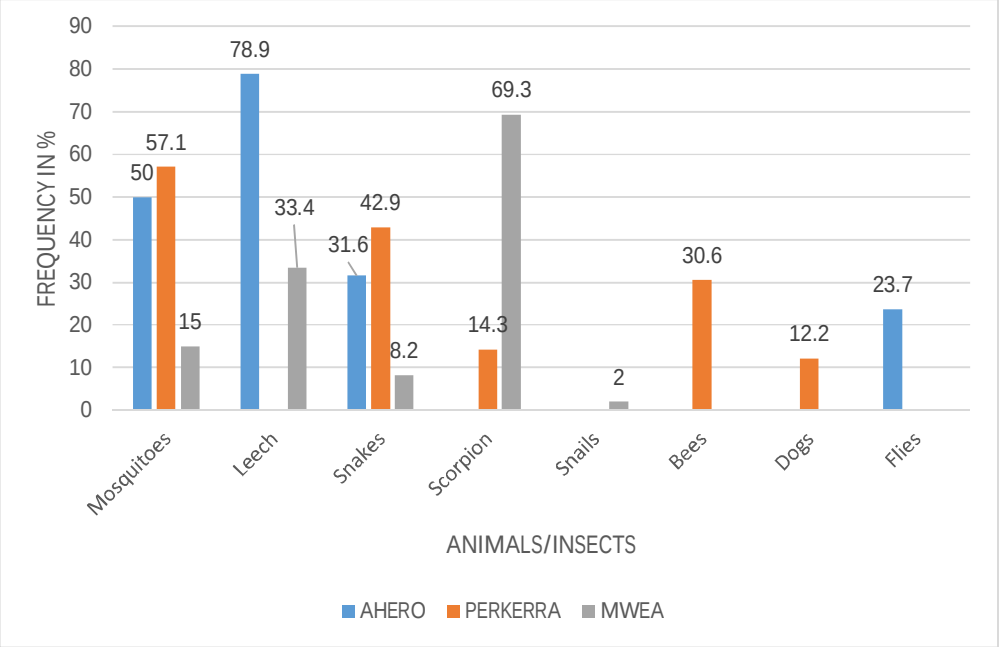


Figure 4.6: Animals/insects likely to bite farmworkers

Farmworkers were more likely to be bitten by mosquitoes in Perkerra and Ahero; leech in Ahero and Mwea; scorpions in Mwea and Perkerra; and bees at Perkerra. Leech lives in stagnant water which is found in rice growing areas of Mwea and Ahero while at Perkerra fruit trees were grown that attracted bees. Mwea had the least likelihood of mosquito bites despite the stagnant irrigation water while Perkerra had the least chance

of stagnant water since the predominant crop was maize unlike rice that required flooding.

In Perkerra mosquitoes were likely to breed in the *Prosopis Juliflora* (mathenge) bushes (Plate 4.2) which dominated the landscape. The results in all the three schemes relate well with the findings of a study in Ghana on cocoa farms (Muilerman, 2013) which stated that bites and stings were common in the farm environment in cocoa growing farms.

Farmers at all the three irrigation schemes kept livestock in their homesteads. When asked to state whether they keep livestock, 54.1% from Ahero, 79.6% from Perkerra and 69.9% from Mwea responded in the affirmative. The livestock included cows, goats and donkeys as observed during the research. The livestock were useful in the production of milk, manure in addition to ploughing and transport carts. 22.9 % of the farmers in Ahero reported that they used ploughs which were animal driven while 92.3% reported that they used handcarts that were bulls driven with 15.4% using donkey driven carts while some used both. In Perkerra livestock was primarily for supply of household milk and meat while at Mwea 91.4%% used ploughs and handcarts that were bull or donkey driven. Over 62% of the carts were bull driven while the rest were donkey driven.

The presence of livestock presents biological hazards through parasites, faecal contamination, and undercooked animal related food (Boischio, Clegg, & Mwagore, 2006) (Langley & Morrow, 2010) Exposure to toxic gases from decomposition of animal waste and exposure to animal allergens may cause adverse health effects in addition to developing numerous zoonotic infections. According to (Lee & Lim, 2008) dust, spores, pollen, poisonous substances and gases develop during the process of farming that could induce respiratory diseases.

Plate 4.2: *Prosopis Juliflora* (Mathenge) bushes at Perkerra – breeding ground for mosquitoes

Clean drinking water was not readily available within the irrigation scheme farms. Farm workers carried their drinking water to the farm which in most cases ended up being inadequate according to the FGD in all the schemes. To supplement the inadequacy, they fetched raw irrigation canal water for drinking. Observations also revealed that there was lack of toilets/latrines on the farms or the surroundings. This was despite the fact that the farm workers work long hours in the farms especially during planting, weeding, and harvesting periods. Consequently, contamination of canal water through defecation and other calls of nature was inevitable as was reported during the FGDs. The nature of the scheme was however not conducive to construction of latrines due to the nature of the marshy land. An environmental impact assessment project report for Mwea – Makima stated that water from River Thiba requires treatment before use (Athi Water Services Board, 2014). Results also from measurements of the water quality standards of Thiba River (Nyambonyi, 2016) showed that the irrigation water had high content of heavy metals and not suitable for domestic use.

4.3.3 Physical hazards

Figure 4.7 shows the various physical hazards experienced in the irrigation farms. All the irrigation schemes had wet and hot work environments and used some form of machine to perform work. It is worth noting that Perkerra did not have any hand cart within the scheme as was also observed by the researcher while Mwea had the highest use of the same. Farm tools were in use in all the schemes.

Some 94.7% of the respondents in Ahero; 99.3% from Mwea; and 95.9% from Perkerra reported that their work involved working in a wet environment. On work in a hot environment, 94.7% from Ahero; 95.8% from Mwea and 100% from Perkerra were in agreement that they work in a hot work environment (Fig 4.7). Observations by the researcher revealed that the landscape was almost flat in both Ahero and Mwea.

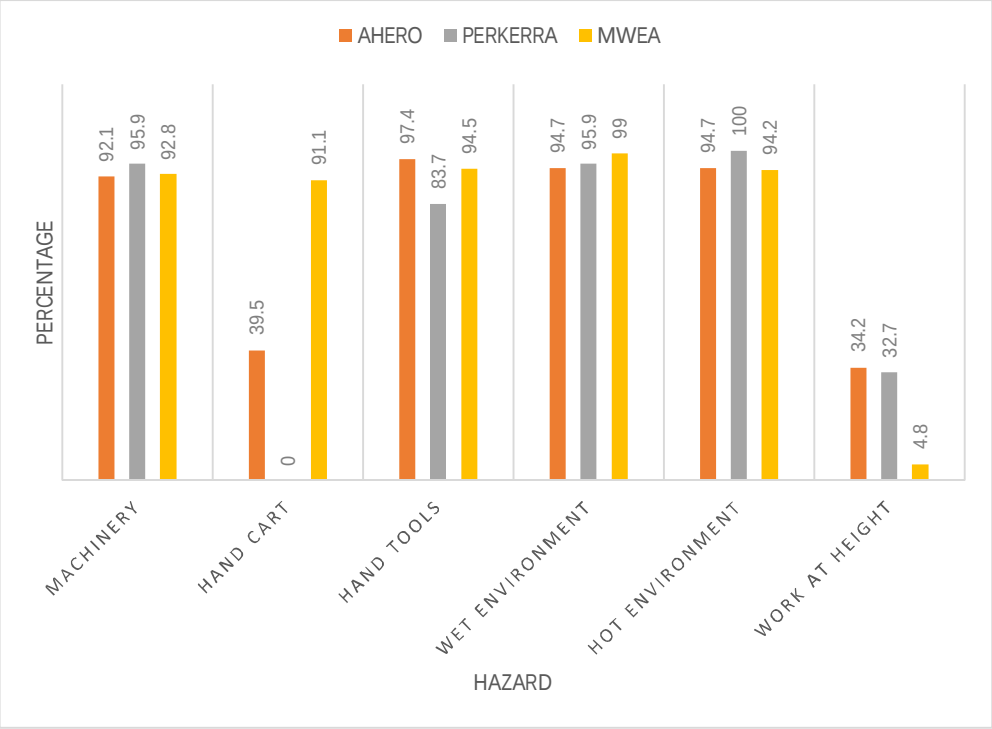


Figure 4.7: Physical hazards in the farms

There were no trees to provide shade and some elements of work involved working inside muddy and wet surfaces. Wet work is defined as activities where workers have

to immerse hands and/or feet in a liquid for a period greater than 2 hours in a working day (Behroozy & keegel, 2014). It has been reported to be a cause for occupational dermatitis (HSE, 2017). Farm workers in both Mwea and Ahero irrigation schemes spend most of their time working with the feet and the hands immersed in water for many hours in a working day (Plate 4.3 and 4.4).

Plate 4.3: Hand weeding in a rice farm

There was very little working at height in Mwea as opposed to Perkerra where farmers grew fruits and Ahero where farmers also had fruits trees at the home compound but not at the rice fields. The risks were however low since such fruits trees were fairly short. Hand tools were used in all schemes with Ahero recording 94.7%; Mwea 94.5%; and Perkerra at 89.1%.

Plate 4.4: Planting rice in a waterlogged farm

Nearly all the farm workers in the three irrigation schemes (94.7% in Ahero; 100% in Perkerra; and 94.2% from Mwea) work in a very hot work environment with temperatures as indicated in Table 2.1. Working in a hot environment for long hours is a likely cause of heat stress. The symptoms of heat stress include inability to concentrate, muscle cramps, heat rash, severe thirst, exhaustion, fainting and heat stroke (HSE, 2018). Heat stroke signs include confusion, loss of consciousness and seizures (OSHA, 2014). The signs of heat exhaustion include headache, nausea, dizziness, and general body weakness.

4.3.3.1 Machinery hazards

All schemes used some form of machine or another as reported by the respondents. Ahero reported 92.1% usage of machinery that included tractor at 82.9%, plough at 22.9% while Perkerra reported usage of machinery at 95.9% that included tractor at 23.4%, knapsack sprayer at 44.7%, motorised sprayer at 23.4% and solo mist sprayer at 19.1%. Mwea on the other hand had machinery usage at 93.2% that included tractor at 66.6%, plough at 1%, combined harvester at 37.5%, and rotavator at 16.4%. It was

however noted that farm workers used more than one form of machinery for the various work in a crop cycle. Plates 4.4 and 4.5 shows some of the machinery used for rice growing in Mwea irrigation scheme.

The use of carts was high in Mwea at 91.4% of those who reported that they use machines, with 97.8% of them being driven by animals; 32.4% being donkey driven and 62.1% being bulls driven. Perkerra scheme did not have hand carts while Ahero had 39.5% of the farm workers owning at least one; 86.7% being animal driven with donkeys at 15.4% and bulls at 92.3% and others owning both. Carts are machines and present physical hazards whether tractor or animal driven

Plate 4.5: Rotavator cultivating in Mwea and donkey cart transporting harvested rice

Those farmworkers who kept livestock were at risk of being hit or crushed by the animals (Boischio, Clegg & Mwagore, 2006). In Mwea, transportation of the produce was predominantly by use of animal propelled carts as was observed during the data collection period.

Plate 4.6: Cultivation using a rotavator in Mwea (note the wet environment)

4.3.3.2 Tools

Tools were used in the whole crop cycle in the three irrigation schemes as observed during the data collection period. There were tools for land preparation, tools for planting, tools for weeding and tools for harvesting. The most popular tools were the hoe (jembe) and the machete (panga). The jembe was used during land preparation in all the three schemes, planting and weeding in Perkerra and also for clearing the irrigation water canals in all the three schemes while the panga fitted in all the above and harvesting in Perkerra. The usage of tools in the irrigation schemes was as shown in the Figure 4.8.

In Ahero 97.4% of the respondents used hand tools in the farms for various farm operations. The respondents who reported to using a hoe (jembe) for tillage amounted to 91.9% while 16.2% of the respondents used a sickle, 78.4% used a machete, 43.2% used the rake and 5.4% used the spade. The sickle was used for harvesting rice and was expected to have a high usage but results show it had been replaced by the machete.

In Perkerra, 89.1% of the respondents indicated that they used tools in the course of their work. The most popular tool was the machete at 78% which was extensively used during land preparation, clearing bushes, planting, weeding and also harvesting. The jembe and spade were used during land preparation, planting and clearing the irrigation canals at 83.7% and 34.1% respectively.

In Mwea, 94.5% of the respondents used hand tools with the most popular tools being the machete at 88.4% and hoe (jembe) at 72.4%. The usage of the sickle was at 14.3% since most of the harvesting work was being carried out by the combined harvester machines. Plate 4.7 depicts the researcher and a farm worker demonstrating how the sickle is used for harvesting.The main hazards of tools are improper and careless use, not being able to recognize hazardous situations and use of sharp tools by farm workers who are under the influence of alcohol and drugs (Millman, 2013).

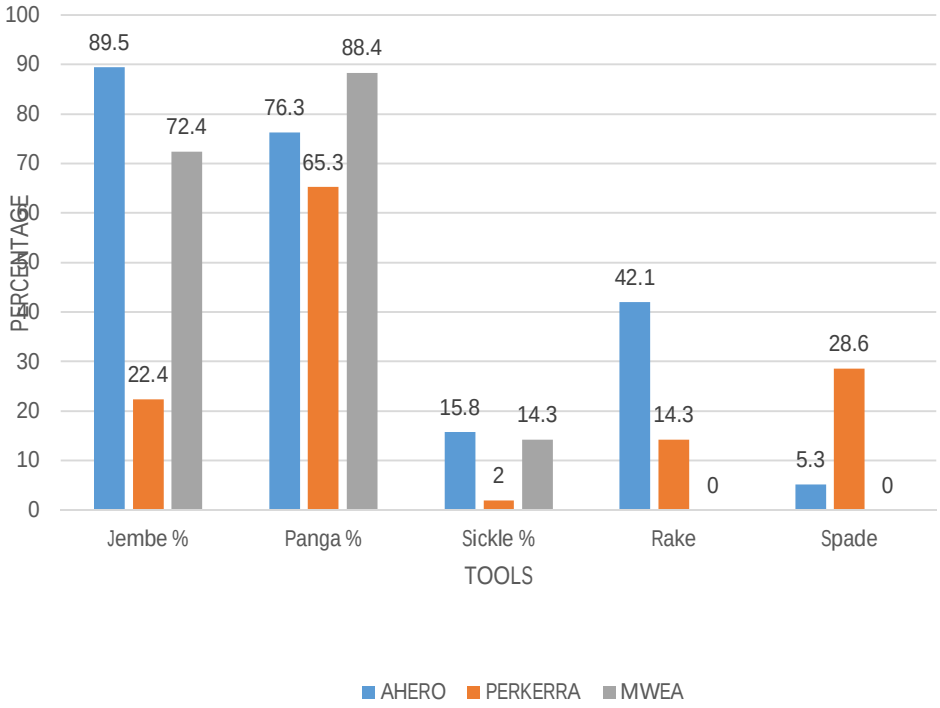


Figure 4.8: Hand tools used in the irrigation schemes

Plate 4.7: Rice harvesting using a sickle at Ahero irrigation scheme

4.3.4 Ergonomic hazards

There are three main risk factors that are utmost priority in agriculture that include lifting and carrying of heavy loads, sustained or full body bending (stooping) and very high repetitive hand working (Fathallah, 2010). Observations in the three schemes revealed that there was a lot of repetitive work and working in awkward postures in the farms throughout the crop cycle (Plates 4.3; 4.4; 4.5; 4.6 and 4.7). Manual ploughing using a jembe, manual planting of maize and rice in all the three schemes, weeding using a panga including hand weeding in rice farms, harvesting of rice in Ahero and Mwea using a sickle and manual threshing, harvesting of maize at Perkerra by cutting the stalks at Perkerra using pangas. Clearing of canals was also carried out using jembe and spade which was also a repetitive job. Workers had to use a lot of force in almost all the work they did using tools and lifting to get the job done. Weeding and manual land preparation in all the schemes including clearing of the irrigation canals was carried out in awkward postures that were likely to present musculoskeletal disorders. The observations built a strong case for musculoskeletal disorders coming as a result of poor ergonomic designs.

The respondents were asked to state if they lifted heavy objects in the course of their work to which 71.1% in Ahero; 74.4% in Mwea; and 79.6% from Perkerra reported that they lift heavy objects. When requested to state what they consider as heavy objects, 44.4% reported manure and fertilizer while 40.7% reported farm produce in Ahero; while in Mwea 62.8% reported farm produce, 7.8% farm tools, and 8.5% manure and fertilizer; in Perkerra, 61.5% reported farm produce, 64.1% manure and fertilizer and 10.3% farm tools. Farm workers were allowed to report more than one item that was heavy in their own assessment. The approximate weights that were lifted were as reported in Figure 4.9.

At Mwea irrigation scheme, majority of the farm workers (58.5%) lifted between 36 – 55 Kgs of weights while overall none of the farm workers reported to lift above 55 Kgs. This is the weight of fertilizers and bags of manure. The practice, as observed during the research period was to contract out transportation of the harvest to third

parties who are not themselves farm workers. In Perkerra, majority of the farm workers (51.3%) lifted weights of between 46 to 55 Kgs. Again these are the weights of fertilizers and manure deliveries to the farms during planting period. The weights of above 66 Kgs lifted by 28.2% of the respondents was from harvested maize loading to the tractor trailers. In Ahero similarly weights of fertilizers were reported by 33.3% of the respondents but of significance is the lifting of loads above 86 kgs which was reported by 40.7% of the respondents. It was observed that there was a lot of manual handling and lifting of heavy loads at Ahero during the harvesting period more than the other irrigation schemes. The weight of between 86 – 90 Kgs was the standard weight of harvested rice for sale at the NIB stores while weights above 100 Kgs was primarily the weights of harvested rice after drying as seen in the plate 4.8 as observed by the researcher. The bag in the plate was weighed in the presence of the researcher and found to weigh 110 Kgs.

There were no prescribed standards on maximum weights that can be lifted by both men and women in Kenya, UK or even USA but the National Institute of Occupational Safety and Health (NIOSH) of USA has developed a formula that should be used by employers while carrying out a lifting risk assessment (Centre for Disease Control [CDC], 2018; Health Safety Executive [HSE], 2018).

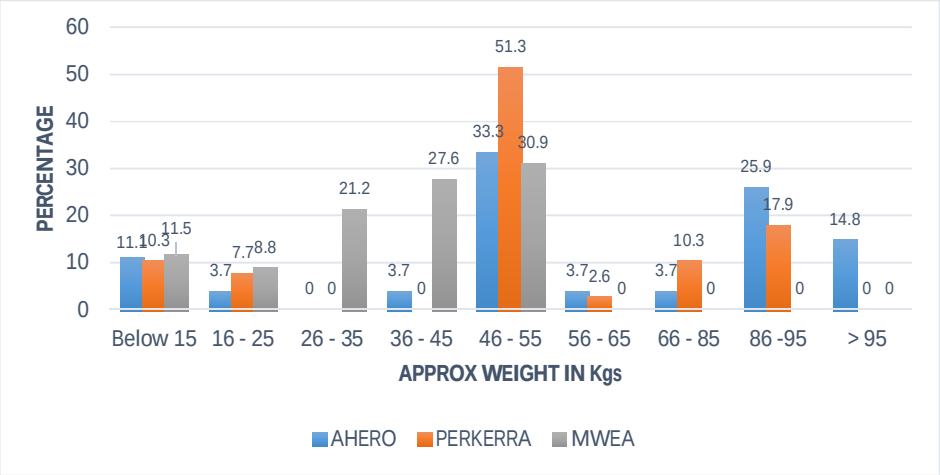


Figure 4.9: Approximate weights lifted by farm workers

Plate 4.8: Lifting heavy loads in Ahero

4.4 Work related injuries and illness inflicted on the irrigation farm workers

4.4.1 Work related injuries

In response to a question on whether they have experienced injuries in the cause of their work, 89.5% in Ahero; 98% in Perkerra and 91.1% at Mwea responded in the affirmative as given in the Table 4.3.

Table 4.3: Incidences of injuries in the irrigation schemes

Scheme		Yes	No	Total
Ahero	Freq	34	4	38
	%	89.5	10.5	100
Mwea	Freq	265	26	291
	%	91.1	8.9	100
Perkerra	Freq	48	1	49
	%	98	2	100

In response to the cause of the injury, 85.3% in Ahero; 97.9% from Perkerra; and 84.5% in Mwea reported that it was due to working tools while 12.5% from Mwea; 2.1% from Perkerra and 8.8% from Ahero reported machinery to be the cause of work related injuries. Some 5.9% of the respondents from Ahero and 2.3% from Mwea indicated lifting of heavy loads while 0.8% from Mwea listed fall from height as shown in Figure 4.10.

Farm tools were the cause of most work related accidents in all the irrigation schemes. Other studies have reported farm tools as the main cause of injuries in developing countries (Lichfield, 1999; Kuye, Donham & Marquez, 2006). Observations indicated that Mwea irrigation scheme had many types of machinery that included combined harvesters, tractors and animal driven carts for harvesting, farm preparation and transportation of farm produce hence the higher number of machinery incidents (12.5%) compared to the other two (Ahero 8.8% and Perkerra 2.1%). In the UK, machinery and tools were the leading causes of work related injuries in the agricultural sector (Health and Safety Executive [HSE], 2017) with 90% of these injuries being caused by hand tools. Similarly, in Korea, machinery was reported to be a major cause of accidents in farms (Lee & Lim, 2008). The difference in prevalence of injuries from machinery could be explained by the fact that both UK and Korea are more industrialized than Kenya and therefore workers handle machinery more than in Kenya. However, according to HSE, the leading cause of non-fatal injuries in agriculture was slip, trip and fall on the same level at 20% overall followed by being

injured by animal at 14% which was different from the findings of this study. In the current study injuries from falls were reported to be only at 0.8% and this was from height.

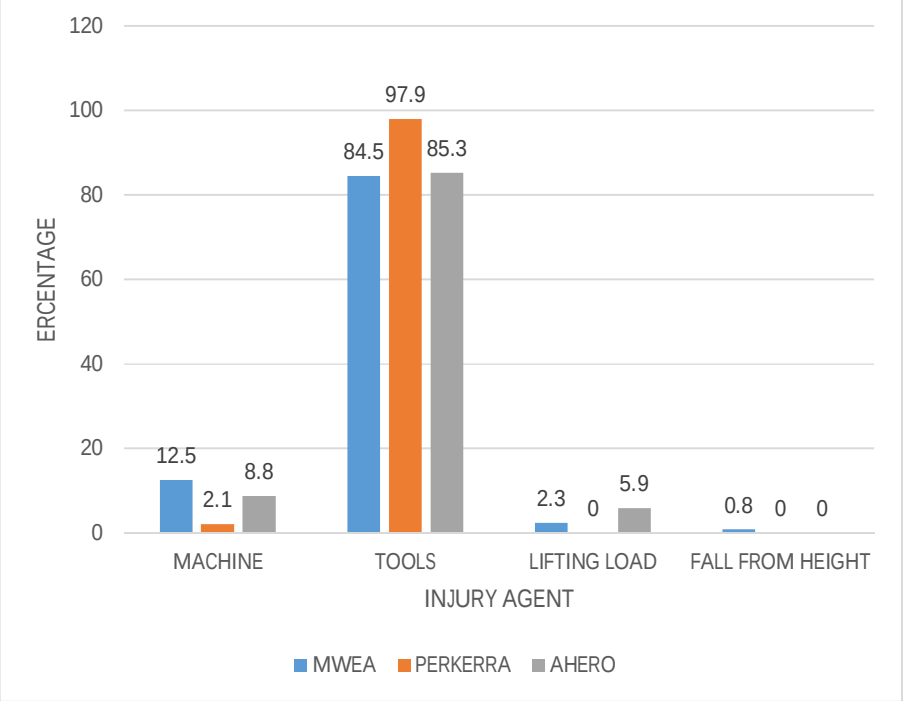


Figure 4.10: Causal agents of injuries

The respondents were asked whether they have persistent pain in the body that may be related to the work they do to which 92.1% in Ahero, 26.5% from Perkerra and 89.6 from Mwea reported in the affirmative. When they were asked to state the parts of the body that ached, 77.1% from Ahero reported the back and 62.9% lower back. This was likely attributable to the lifting of heavy weights (Fig 4.9). All other parts of the body for Ahero respondents were paining more than other irrigation schemes as shown in Figure 4.11. In Perkerra the back pain was high at 35.7% followed by lower back at 21.4% while in Mwea shoulder pains were leading with 34.4% and the back with 25.1 %. The shoulder pains were possibly due to the repetitive nature of work in the farms but there was minimum lifting of loads. Ahero farm workers had pain in all the

recorded parts of the body more than any other irrigation scheme and from Figure 4.9, it emerges that the farm workers in Ahero lifted the heaviest loads with 14.8% lifting above 95 Kgs.

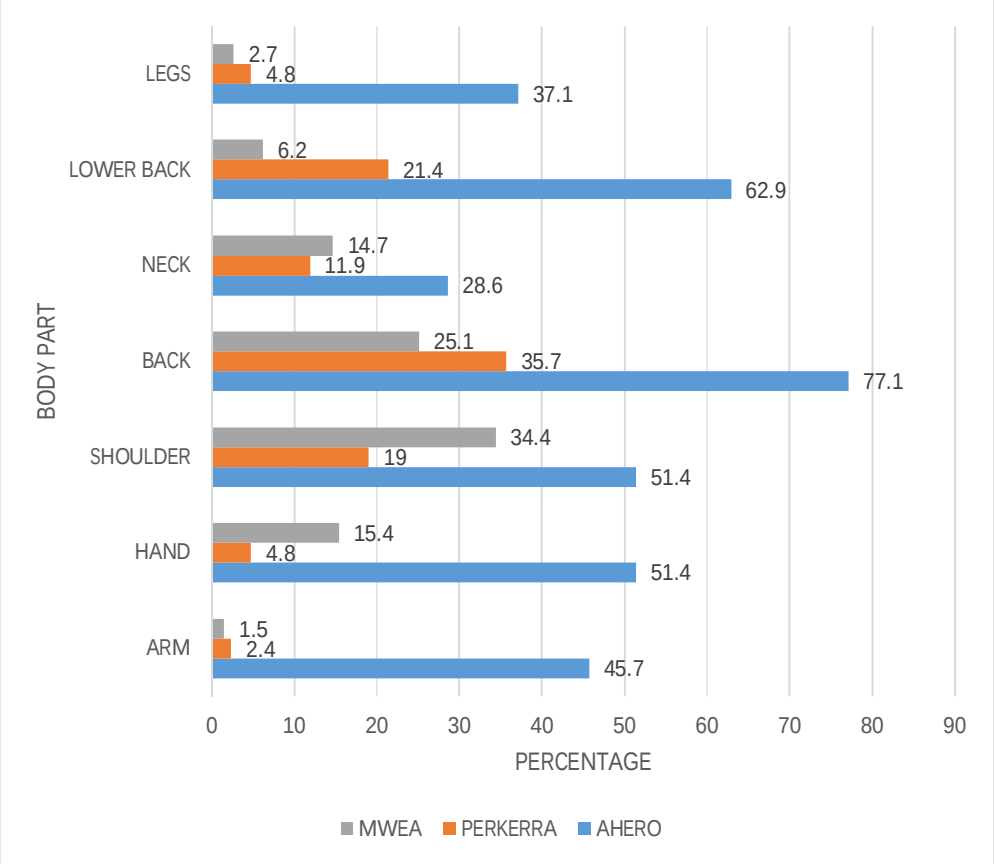


Figure 4.11: Parts of the body with pain

A Chi Square test was used to measure the relationship between lifting of heavy loads in which it was found that there was a significant correlation between lifting of heavy loads and work related body pains in Ahero irrigation scheme ($X^2=4.234$, df=1, p=0.040) (Appendix 11). In Perkerra and Mwea there was no relationship. The difference in the correlation implied that there were other risk factors that caused body pains at Perkerra and Mwea other than lifting heavy loads. In Ahero, lifting of the loads was a key risk factor for body pains.

It is worth noting that Perkerra had the least injuries associated with lifting of loads. Unlike Mwea and Ahero, farmers in Perkerra grew maize that was transported by means of tractor trailers while rice was stuffed in gunny bags above 90 Kgs during harvesting. The heaviest loads lifted at Perkerra was 90 Kgs of possibly maize while at Ahero weights of above 100 Kgs was normal. Plate 4.9 shows a combined harvester crew member carrying a bag of harvested rice.

Plate 4.9: Carrying harvested rice in Mwea by contracted employee

Plate 4.10: Harvesting maize in Perkerra

A Chi Square test was carried out to establish whether there were differences with respect to gender and age and education with being injured while at work. Results indicated that there was no significant statistical relationship between age or gender with being injured while at work in all the three irrigation schemes (Table 4.4). Work related injuries were therefore not influenced by either gender or age of the farm worker.

There was however a statistical significance in Mwea in the level of education with being injured at work (X^2=16.948, df=4, p=0.002) and no significance in both Perkerra and Ahero (X^2=1.361, df=4, p=0.851 for Perkerra and X^2=1.774, df=3, p=0.621 for Ahero) (Table 4.2). Mwea, farm workers with higher levels of education were less likely to get injured while at work compared to their colleagues in Perkerra and Ahero.

Table 4.4: Chi Square test results for being injured with gender, age and education

Variable	Scheme	Chi square test results		
		X^2	df	P value
Gender	Ahero	2.362	1	0.124
	Mwea	0.235	1	0.628
	Perkerra	0.408	1	0.523
Age	Ahero	3.954	3	0.266
	Mwea	7.045	4	0.134
	Perkerra	1.154	4	0.886
Education	Ahero	1.774	3	0.621
	Mwea	16.948	4	0.002
	Erkerra	1.361	4	0.851

In response to a question on the body parts that have been frequently injured, 55.9% of the respondents in Ahero, 79.2% from Perkerra and 77.7% from Mwea reported the leg to be the most vulnerable. Another 32.4% from Ahero, 18.8% from Perkerra and 13.6% from Mwea indicated the hand to be more vulnerable as shown in Figure 4.12. In all the three irrigation schemes, the most widely used tools were the machete (panga) and the hoe (jembe) as shown in Figure 4.8. These two tools were used throughout the crop cycle for land preparation, planting, weeding and harvesting as was observed by the researcher. The hand and the leg were therefore vulnerable to the actions of these tools especially if the tool was defective. Other tools in use included the sickle, the spade, rake and slasher. There was more manual work involving use of machete at Perkerra especially during planting and harvesting where the leg became more vulnerable to cuts. Other studies that corroborates with this study was in Gambia (Kuye, Donham & Marquez, 2006) where injuries to the foot was rated at 68.4% and the hand at 10.5%. The study was in support with the results of other studies (Lee & Lim, 2008; Finnegan, 2007) where most accidents were traced to be coming from the use of machinery and tools despite the levels of technological differences between

Kenya, Korea and Ireland. Plate 4.9 shows a farm worker harvesting maize using a machete in Perkerra.

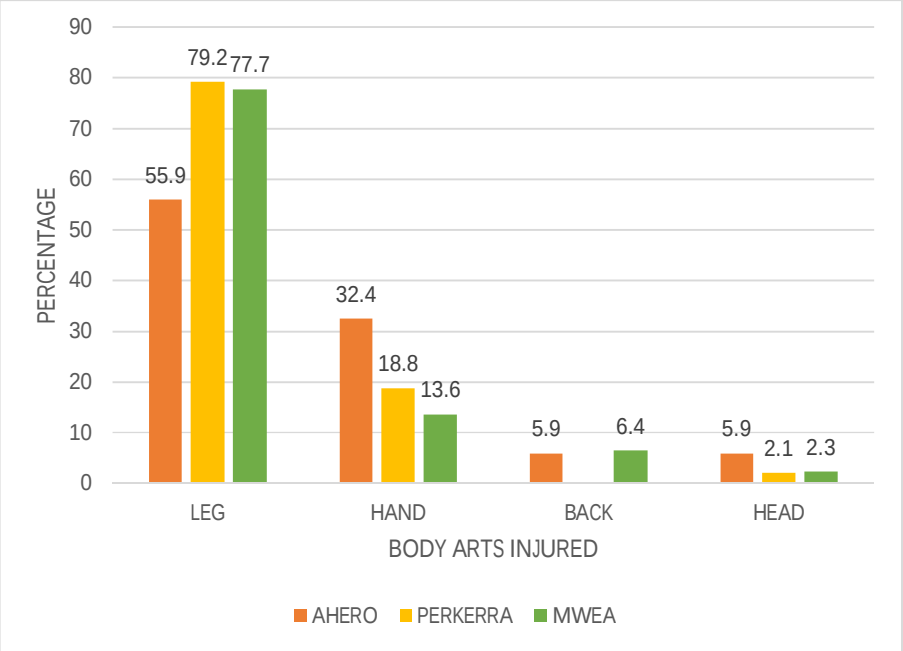


Figure 4.12: Body parts injured

4.4.2 Work related ill-health

The respondents were asked whether they or a member of their family had ever been taken ill after spraying chemicals to which in Ahero, 60.5% responded positively. In Perkerra, 36.7% reported yes while in Mwea 59.6% also answered in the affirmative. The respondents who could not remember whether they or a member of their family had been taken ill after spraying chemicals were 7.9% in Ahero, 2% from Perkerra and 3.8% from Mwea. Details of the results is as illustrated in Figure 4.13. In a previous study (Mburu, 2006), 39% of the respondents fell sick after spraying chemicals which was fairly low compared with the present study especially the case of Ahero. In the previous case there was corporate responsibility from the tobacco sponsoring companies as opposed to the current cases. In Perkerra which compares well with the Mitunguu study, the maize seed growing was sponsored by seed companies just as was the case with tobacco growing hence the low number of incidences.

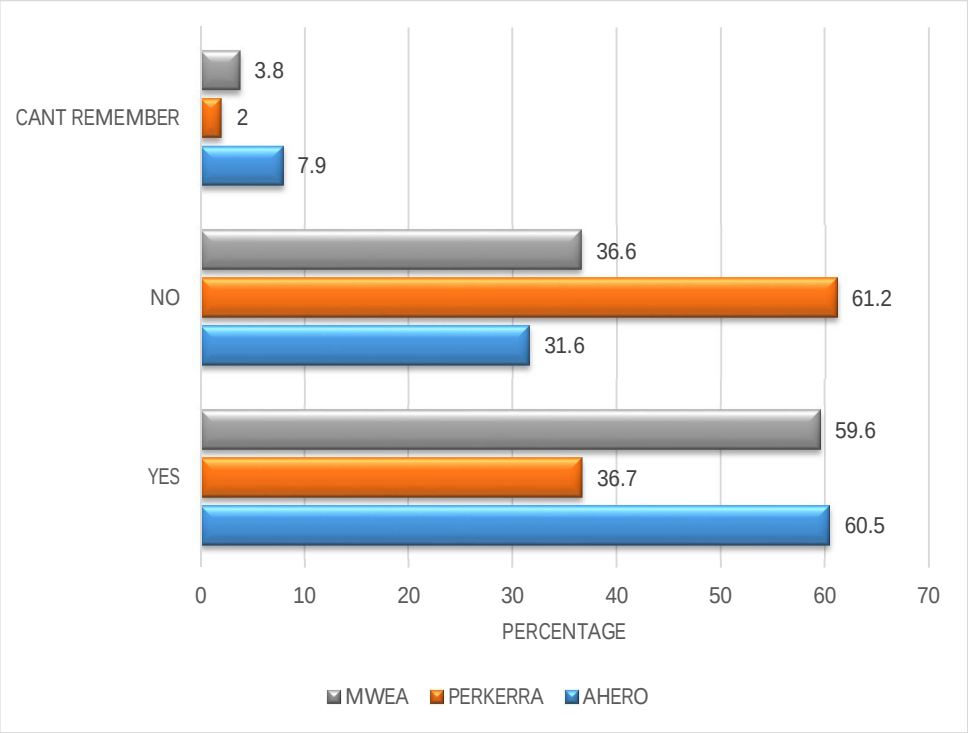


Figure 4.13: Farm workers taken ill after spraying chemicals

Those farm workers who became ill and were admitted in hospital were 21.7% in Ahero, 11.1% in Perkerra and 12.2% in Mwea. About 65.2% of the respondents from Ahero, 66.7% from Perkerra and 22.4% from Mwea were treated as outpatients in hospitals while 13% from Ahero, 22.2% from Perkerra and 65.4% from Mwea were treated at home. The scheme with the highest admissions in hospital was Ahero while Mwea had the highest number of self-treatment cases. Figure 4.14 shows how and where the ailing farm workers were treated.

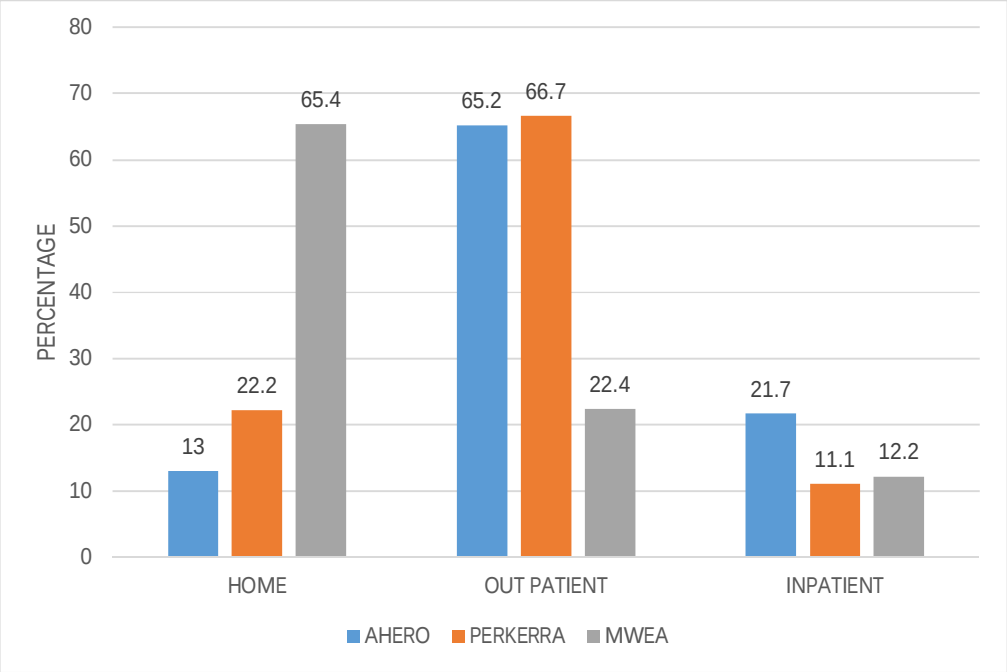


Figure 4.14: Where symptoms of chemical exposure were treated

The respondents reported a variety of symptoms arising from the use of chemicals. In Ahero, the most prevalent symptoms were vomiting at 26.1%, sneezing at 17.4% and headache at 13%. Other symptoms included dizziness and breathing problems each at 8.7%. In Perkerra, the main symptoms were sneezing at 38.9%, dizziness at 27.8% and headache at 22.2%. Other symptoms included vomiting and breathing problems at 5.6% each. In Mwea, sneezing was top of the symptoms at 28.2% followed by vomiting at 22.4% and dizziness at 18.4%. Other symptoms were headache at 10.9%, breathing problems at 9.2%, loss of sleep at 6.9% and skin rashes at 4% respectively. Figure 4.15 depicts the various symptoms as experienced by the respondents. In the Ethiopian study (Karunamoorthi et al., 2012), headache (58.8%), salivation and vomiting (38.2%), nausea (36.5%), and sneezing (12.5%) were the most prevalent symptoms. In Philippines, (Sheira and Cesar, 2015) the main symptoms were reported as nail problems, skin irritation, burning sensation at the back, eye irritation, severe dry throat dizziness and excessive sweating among others. The type of symptoms experienced in each country/site is however dependent on the toxicity of chemicals used, length of exposure, methods of handling and type of protection used.

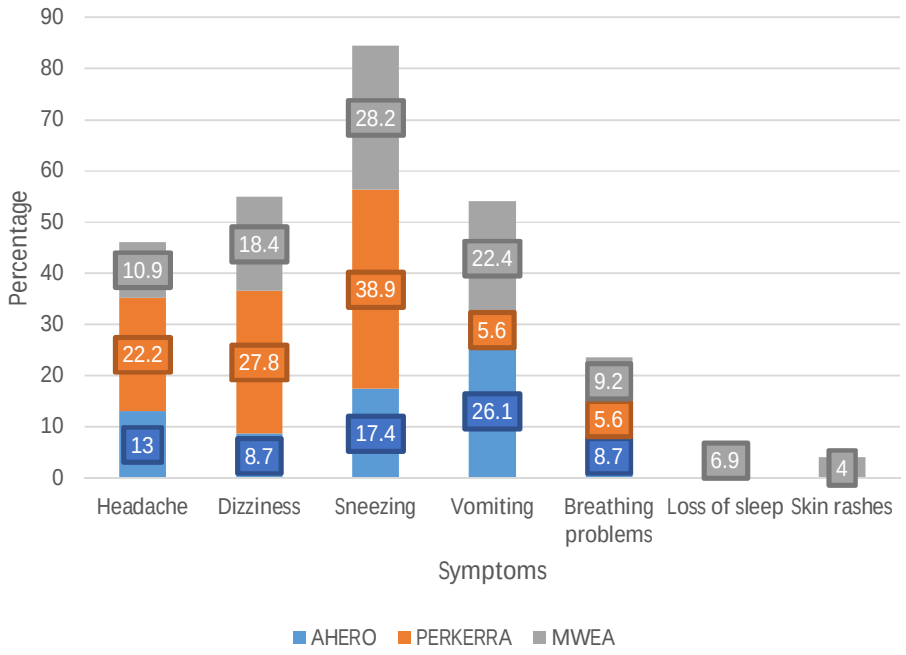


Figure 4.15: Self-reported symptoms of chemical exposure

The respondents were asked to state if they had been admitted to the hospital within the last 12 months and if so what were the ailments to which in Ahero, 46.2% of the respondents had suffered from Malaria, 3.8% suffered from Bilharzia, 26.9% had suffered from Typhoid, 11.5% reported to be having pain in the body within the last one year as shown in Figure 4.16. In Mwea, Malaria was 46.2%, Bilharzia 18.3%, Typhoid 18.3%, Back pains 5.4% and others 5.4% while in Perkerra, Malaria was at 50%, Bilharzia at 16.7%, Typhoid 25% and others 8.3%. There were no cases of back pains and arching bones that led to hospital admission.

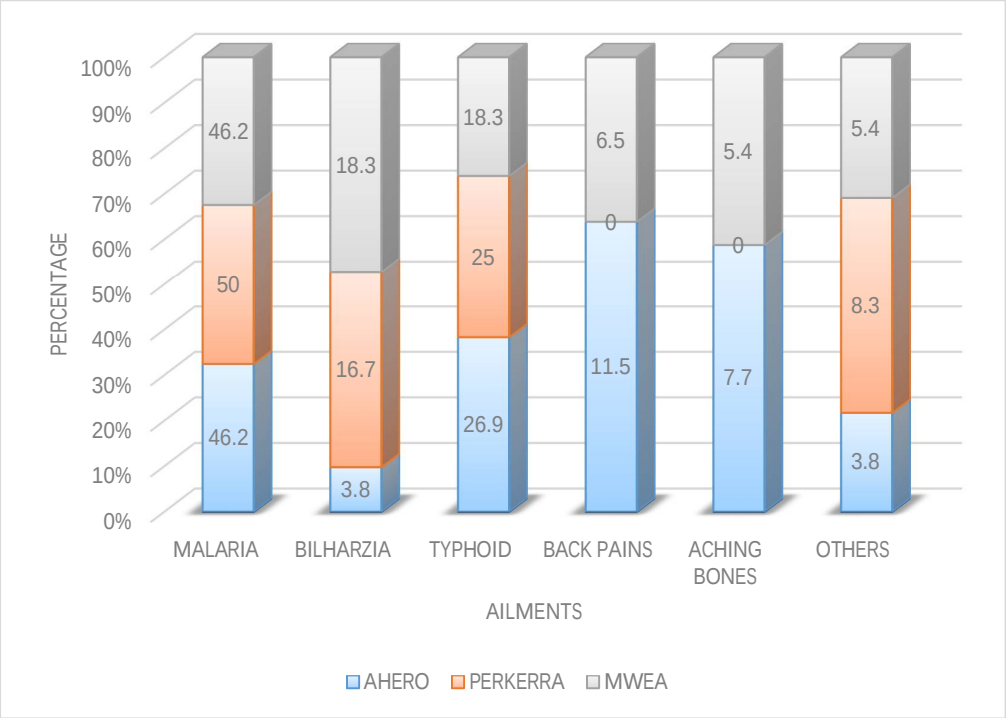


Figure 4.16: Self-reported diseases that caused admissions (Respondents)

Results from 4 health care providers at Ahero scheme indicated that the most significant ailments were malaria, gastroenteritis, skin diseases, cuts and wounds and STI's. All these ailments had a relevance to the nature of work carried out in the scheme. Mosquitoes breeds in stagnant water hence high levels of malaria treatment. Out of 280 patients treated daily, 39.9% were malaria cases. Gastroenteritis (11.1%) and typhoid (6.8%) were likely to be high out of using contaminated water while in the farms since clean water was not readily available at the farms. Skin diseases, cuts and wounds were also significant at 10.7% and 10.4% respectively arising from chemicals use and injuries inflicted by tools and animals as indicated in Figure 4.17. The results were fairly comparable with those reported by the respondents (Fig 4.16) in that Malaria was leading with 39.9% at Ahero compared to the respondent's 46.2%. The results of the study corroborates well with the one carried out in Nigeria (Okereke& Okereke, 2015) that identified Malaria as the leading disease in the rice growing area of Ebonyi state.

In Perkerra, 50% of the respondents indicated they had suffered from Malaria, 16.7% had suffered from Bilharzia, 25% Typhoid within the last one year that resulted in hospital admission (fig 4.19). The part of the body that pained most was the back at 35.7%, lower back at 21.4%, and shoulder at 19% and neck at 11.9%. Analysis from data collected from three health care providers within Perkerra irrigation scheme indicated that the most significant ailments were upper respiratory tract infection (URTI) at 28.3% followed by typhoid and malaria at 11.7% and 9.1% respectively as indicated in Figure 4.17. The URTI cases may be related to exposure to chemicals and high exposures to organic and pollen dust (Fig 4.5)

In Mwea, 46.2% of the respondents indicated that they had suffered from Malaria, 18.3% had suffered from Bilharzia attack, and 18.3% had suffered Typhoid, while 11.9% suffered from body pains that led to hospital admission. The body pains were on the shoulder at 34.4%, back at 25.1%, and hand at 15.4% and neck at 14.7% as was shown in Figure 4.11.

Analysis from data collected from six health care providers within Mwea scheme showed that, upper respiratory diseases (URTI) emerged as the most prevalent at 46.3% with no malaria case being reported as is shown in Figure 4.17. In production agriculture, farmers are likely to be exposed to toxic gases and contaminated particulate matter that can cause short and long term health problems (Respiratory illness associated with agriculture, 2012) The high cases of URTI may be attributed to high usage of organophosphate chemicals and exposure to organic dusts in the farms including gases from decomposing vegetable matter and animal manure. The use of organophosphate (Sumithion Fig 4.2 c) is suspected to be a contributor to the ailment.

Results from Figure 4.16 show that Malaria, bilharzia and typhoid were the three ailments that were reported by the respondents as common to the three schemes to be the cause of their hospitalization. Back pains and aching bones were been reported to be prevalent in Ahero and Mwea. This cases of pain may be related to carrying of heavy loads especially at Ahero and repetitive work in both schemes. At the FGD in Mwea it came out that joint pains only become active when farmworkers spend the

day working in a wet environment with the feet and hands immersed in water most of the time.

The Figure 4.17 shows the comparison of the prevalence of the diseases in the three irrigation schemes as reported by the health care providers. The prevalence of malaria was reported to be predominant in Ahero and to a slight extent in Perkerra. This corroborates well with the data collected from the respondents through the interview. Mwea HCP on the other hand reported no malaria cases from among the top ailments whereas the interview indicated a significant prevalence. Information from the HCP indicated that there had been a lot of research focussing on eradication of Malaria in Mwea over the last couple of years. This in addition to the vector borne disease research based at Kimbimbi Sub-county hospital has helped to fight the vice.

Mwea and Perkerra had high prevalence of Upper Respiratory Tract Infection (URTI) with minimal cases in Ahero. According to Lee K and Lim H, (2008), dust, spores, pollen, poisonous substances and gases developed during the process of farming, could induce rhinitis, bronchial asthma, hypersensitivity pneumonitis and bronchitis which all fall under URTI.

Through FGD in Ahero, it emerged that the respondents were aware of the causes of malaria and how it could be prevented. There were a number of organizations that were conducting civic education on prevention of malaria with residents being issued with treated mosquito bed nets but there were challenges on the usage. Men believed that the nets were for mothers and children hence did not use them while others believed the nets did not present 24 hours cover hence no need to protect themselves for only a short period of time. There was a higher probability of male contacting Malaria in Ahero than female $X^2=8.876$, df =1, p=0.003. Out of the 71.9% cases of Malaria in the scheme, 50% were male as seen in Table 4.5.

Table 4.5: Cross tabulation of gender with malaria cases at Ahero

			Malaria cases		Total
			Yes	No	
Gender	Male	Freq	16	1	17
		% of Total	50.0%	3.1%	53.1%
	Female	Freq	7	8	15
		% of Total	21.9%	25.0%	46.9%
Total		Feq	23	9	32
		% of Total	71.9%	28.1%	100.0%

In Perkerra, pneumonia and amoeba attacks were not reported among the top ailments, but high prevalence of typhoid and eye ailments were noted (Fig 4.17). The high prevalence of Typhoid may be attributed to drinking water and hygiene conditions in the farms. Through the FGD it was realised that men did not use the treated mosquito bed nets issued by the Ministry of Health due to cultural practices. Wounds were also more pronounced in Perkerra arising from the thorns and stumps of the *Prosopis Juliflora* (mathenge) shrubs that were prevalent in the area. Eye injuries were also prevalent due to the thorns of the cactus and mathenge bushes which also acts as breeding grounds for mosquitoes.

In Mwea, there was presence of amoeba attacks and joint pains that was higher compared to the other two schemes. Those who earlier indicated to have had malaria attack from Mwea reported in the FGD that they never sought laboratory tests to confirm presence of malaria parasites. In Kirinyaga county, there were 15,816 cases of clinical Malaria while only 924 cases were confirmed as Malaria (KNBS, 2015) and in 2016, there were 2,271 suspected cases of Malaria but only 173 cases were confirmed positively (KNBS, 2017). Other cases of ailments in Kirinyaga county recorded by the national statistics body in 2016 included 76,508 cases of joint pains, 83,975 cases of skin diseases, 15,674 cases of eye infection, 512 cases of bilharzia, 22,055 cases of injuries and 124 cases of snake bites among others. It was not however possible to isolate specific numbers of these ailments arising from Mwea irrigation scheme.

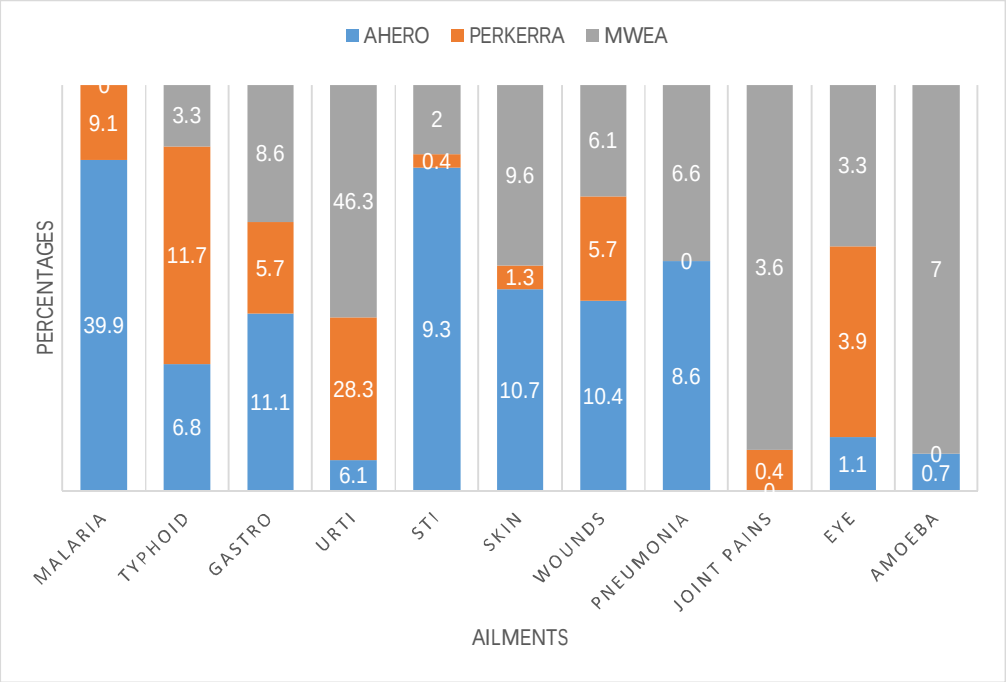


Figure 4.17: Daily disease prevalence in the irrigation schemes as reported from HCP

The joint pains were unique (as reported in the FGD meeting) in that it affected the farm workers whenever they worked under wet environment and ceased when the season changes. Pain was centralised on the hand and feet joints that were immersed under water which qualifies it as an occupational ailment. Based on the national statistics report, it is possible that the malaria cases as reported by the respondents may not have been confirmed positively but purely a perception.

The results of ill health in the three schemes corroborates with the decent work in agriculture report (ILO, 2003) which stated that much ill health was due to respiratory and intestinal diseases. The report associated these conditions with poor housing conditions and poor levels of nutrition with special attention to the importance of access to water and sanitation but in the current study, it should be attributed to unsafe working conditions and poor hygiene on the farms.

The result was also comparable to the national incidences of diseases in Kenya 2011 – 2015 (KNBS, 2016). The results showed that Malaria incidences had dropped significantly from 2011 to 2015 while diseases of the respiratory system that includes URTI have been gradually increasing. This results validates the findings in Mwea irrigation scheme which was the largest public irrigation scheme in Kenya at the time of the study. The diseases with the highest incidences in the national incidences report were URTI (38.8%), Malaria (16.5%), Skin (10.1%) diseases and Diarrhoea diseases (6.8%). A study in America (Von Essen SG, 1997) reported that grain dust, dust and gases in animal confinement units play an important role in causing respiratory disorders to farmers. The researcher singled out other substances in organic dust including mycotoxins and silica. Chronic bronchitis was cited as being more common to farmers than the general population. In the same reasoning, grain dust may be a big contributor to the URTI diseases in the irrigation schemes.

The results also corroborates well with the study conducted in Korea (Lee & Lim, 2008) that identified pesticide poisoning, respiratory diseases and musculoskeletal ailments as being among the most prevalent among Korean farmers.

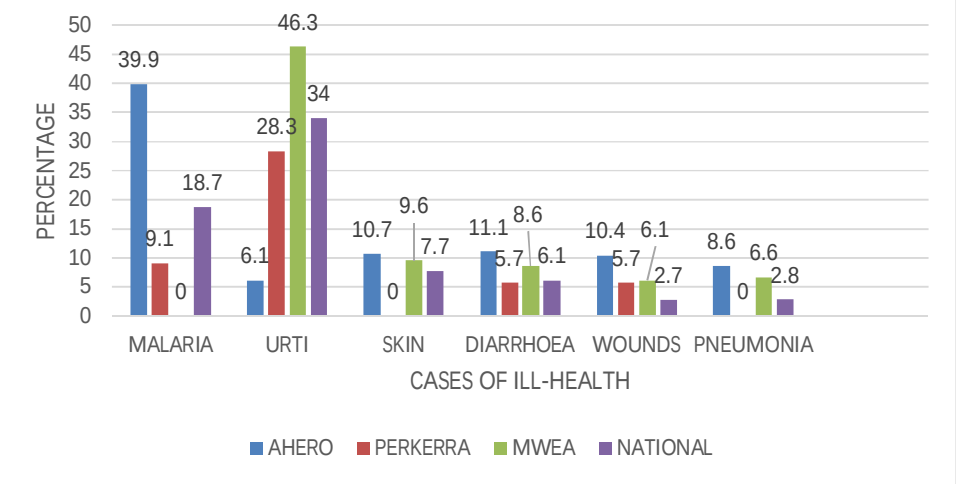


Figure 4.18: Comparison of key endemic diseases from HCP with national data for 2017

When compared with national statistics for 2017 (Fig 4.18), Malaria was high in Ahero at 39.9% compared with the national occurrences of 18.7% with URTI being also on

the higher side at Mwea (46.3%) compared with the national occurrences of 34% (KNBS, 2018). Working in water logged environment as happens at Ahero and Mwea has the effect of increase in mosquito breeding and unless measures are taken the malaria incidences are bound to increase. Other diseases where the incidents surpass those of the national statistics include, wounds in all the three schemes, Skin, diarrhoea and Pneumonia in Ahero and Mwea as can be seen in Figure 4.18. The incidence of diseases causing morbidity for the period 2013 to 2017 is presented in Appendix 10. Malaria and respiratory infections continued to be the leading diseases collectively accounting for 52.7 per cent of total diseases causing morbidity in the country. The number of reported malaria cases continued to decline by 19.6 per cent to 7,770,124 in 2015. This may be attributed to the Ministry of Health anti-malaria campaigns (KNBS, 2016).

Lack of clean drinking water was a contributor to the high incidences of gastro related ailments leading to diarrhoea. Drinking of contaminated irrigation water from the canals in a place that is deficient of good sanitation as happens in Ahero and Mwea irrigation schemes was bound to increase the prevalence of the said ailments.

Those farm workers who sprayed agrochemicals were not at a greater risk of being admitted to hospital due to illness compared to those that did not spray since there was no significant correlation X^2==2.225, df=1, p=0.136 for Ahero; X^2=1.533, df=1, p=0.216 for Perkerra; and X^2=1.693, df=1, p=0.193 for Mwea (Appendix 11).

4.5 The constraints to good OSH practices

4.5.1 Ahero irrigation scheme

In Ahero irrigation scheme, majority of the farm workers (68.4%) were aware that there is a law in Kenya that protects workers from work related injuries and ill-health while 18.4% were not aware and 13.2% neither agree nor disagree giving rise to a mean value of 2.39 signifying fair level of awareness of the existence of the law as indicated in Figure 4.19. The standard deviation at 1.405 was however high which may imply non confidence of the respondents. Please note that the Likert scale used was

as defined in section 3.8 and the values given in the chart are the mean values for each statement on a scale of 1 to 5.

In the focus group discussion, it emerged that the respondents were not aware of the specific law nor were they aware of the government body (ministry) that would enforce such a law. They believed that there cannot be any vacuum in the legislation.

Figure 4.19: Constraints to good OSH practice in Ahero irrigation scheme

On the use of personal protective equipment (PPE), 81.6% of farm workers were aware of their importance in the prevention of injuries and ill-health while only 7.9% were not aware. 10.5% were undecided (mean = 2.0). About 69.4% were in agreement that the PPEs were available in the local shops (mean =2.28) but only 52.6% were in

agreement that they were affordable (mean = 2.71). Majority of the farm workers were aware of the importance of reading chemical labels (68.4%) (mean = 2.11) before handling them however 21.1% were not decided while 10.5% did not agree. In the focus group discussion, it was came out clearly that the farm workers were aware that chemicals were harmful and that they needed protection. From the observations, it was realised that chemicals were in use almost throughout the crop cycle: during land preparation, herbicides were used to remove weed; during planting chemicals are handled from seeds (preservation); during transplantation, fertilizers and fungicides were used, at weeding selective herbicides were used to kill weeds and during crop growing period, pesticides and fungicides were used extensively.

With reference to work in an environment of stagnant water, 92.1% were in agreement that it was likely to cause diseases while only 7.9% were not sure (mean = 1.63). On lifting of heavy loads, 81.5% were aware that lifting of heavy loads was likely to cause ill-health (mean = 1.79). On the maintenance of machinery 86.8% were aware of the importance of good machine maintenance (mean = 1.92).

On training, 61.1% had been trained on safe work practices (mean = 2.67) while 57.9% had been trained on the need to wear protective equipment (mean = 2.74). As to who conducted the training, 65.7% reported that the local agricultural officer conducted the training (mean 2.42). 60.5% of the respondents reported that they were advised on the type of chemicals to use in their farms (mean = 2.55). From the focus group meeting, the team reported that the local agricultural officers organised for the training with suppliers of the chemicals who trained and advised on the chemicals to be used (marketing approach).

The study noted from Figure 4.19 that, the key constrains that hinders good OSH practice at Ahero irrigation scheme being –

i. Lack of effective training
ii. Lack of advisory services on suitable chemicals
iii. Ignorance on existence of an OSH law
iv. Knowledge on PPE's

v. Economic ability to procure PPE

There was no significant relationship between level of education and the knowledge on the existence of an OSH law (X^2=10.384, df=9, p=0.320). Farm workers had never heard of the Directorate of Occupational Safety and Health Services and the law they enforce (as it emerged from the FGD while discussing the regulating authorities). This signified the invisibility of OSH regulatory body in the irrigation scheme.

There was no significant correlation between being trained on safe work practices and

i. Knowledge that lifting of heavy loads is likely to cause ill-health (X^2=11.319, df=12, p=0.502)
ii. The importance of reading chemical labels before handling (X^2=16.757, df=16, pp=0.401)
iii. Consequences of not using PPE while handling chemicals (X^2=11.337, df=12, p=0.500)
iv. Availability of PPE's in the local market (X^2=22.578, df=16, p=0.125)

The type of training given to the farm workers did not address pertinent issues with regard to their safety and health. From the FGD, it emerged that the training was more market oriented for the farmers to use a particular type of chemical from a particular supplier without due consideration to their safety and health. The mode of content delivery may have not been favourable to the farm workers since those who were trained could not understand that lifting of loads causes ill-health; the importance of reading chemical labels; the consequence of not wearing PPEs and also were not able to identify PPEs from the local market. Effective training was therefore a major constrain to the application of good OSH practices.

The income of the farm workers in Ahero was fairly low with a mean value of Ksh 49,200 per annum (Fig 4.2). This coupled with other competing priorities like food and payment of school fees made the farm workers to give procurement of PPEs low priority

4.5.2 Mwea irrigation scheme

In Mwea, only 2.4% of the respondents strongly agree that there is a law to protect workers in Kenya while 36.3% agree, 21.9% neither agree nor disagree, 27.1% disagree and 12.3% strongly disagree. Only 18.8% of the respondents strongly agree that farmers who do not wear PPE while handling chemicals stand a high chance of dying while 46.9% agree, 16.8% neither agree nor disagree, 16.1% disagree and 1.4% strongly disagree. Figure 4.22 has given the detailed results of all the responses from the respondents in mean values. Any value of mean giving higher than 2 meant that the respondent was not sure or was in disagreement with the statements.

A close examination of Figure 4.20, reveals that the main constraints in Mwea irrigation scheme were:

i. Lack of effective training
ii. Lack of advisory services on chemicals
iii. Ignorance on existence of an OSH law
iv. Knowledge on PPE's
v. Economic ability to procure PPE

There was no statistical relation between level of education and the knowledge of the existence of an OSH law (X^2=19.019, df=16, p=0.268). The level of education had no relevance on the awareness of the existence of the law and as was reported for Ahero this signified the invisibility of the regulatory authority of OSH issues in the irrigation scheme.

Farm workers who were trained on safe work practices were expected to have a better understanding on their vulnerability to OSH hazards and therefore apply better practices. A Chi Square test revealed that, there was a significant statistical relationship between being trained on safe work practices and the knowledge that lifting of heavy loads was likely to cause ill-health (X^2=29.776, df=16, p=0.019) and the knowledge that PPEs were available in the local market (X^2=47.865, df=16, p=0.000). There was however no significant statistical relationship between being trained on safe work practices and the knowledge that those farm workers who do not wear PPE while

handling chemicals stand a high chance of dying (X^2=18.651,df=16, p=0.287) and the knowledge that it was important to read chemical labels before handling (X^2=26.221, df=16, p=0.051).

Figure 4.20: Constraints to good OSH practices in Mwea irrigation scheme

The farm workers in Mwea who were trained in safe work practices knew what PPE's were and were able to spot their availability as opposed to those not trained. The two key area that were deficient was the vulnerability of the chemicals that included both reading the labels and wearing of PPEs as can be seen in table 4.6. Overall there was a high level of understanding of safety issues in Mwea but their knowledge was not realised in practice by the researcher in the observation phase of the research.

Table 4.6: Chi Square results for being trained in safe work procedures with other variables

Variables	Chi square results		
	X^2	df	P value
Lifting heavy loads is likely to cause ill-health	29.776	16	0.019
Personal protective equipment are available in the shops	47.865	16	0.000
Farmers who do not use PPE while handling chemicals stand a high chance of dying	18.651	16	0.287
It is important to read chemical labels before handling them	26.221	16	0.051

4.5.3 Perkerra irrigation scheme

In Perkerra, 12.2% of the respondents strongly agreed that there was a law in Kenya to protect workers while 34.7% agreed, 18.4% did not agree nor disagreed, 22.4% disagreed and 12.2% strongly disagreed. On the consequences of the farmers who did not wear PPEs while handling chemicals, 18.4% strongly agreed that they stood a high chance of dying while 75.5% were in agreement, 4.1% disagreed and 2% strongly disagreed. On having been trained on safe work practices, only 2% strongly agreed that they have been trained, 49% agreed, 6.1% neither agreed nor disagreed, 40.8% disagreed while 2% strongly disagreed. The details of all the responses from all respondents in the three irrigation schemes are as shown in Figure 4.21.

From Figure 4.21, the main constraints for Perkerra irrigation scheme were noted as:

i. Lack of effective training
ii. Lack of advisory services on chemicals
iii. Ignorance on existence of an OSH law
iv. Knowledge on PPE's
v. Economic ability to procure PPE

There was no significant relationship between being educated and the knowledge of the existence of the OSH law meaning the level of the knowledge did not influence the knowledge (X^2=12.609, df=16, p=0.701). Just like the other irrigation schemes, the presence of OSH officials in the irrigation schemes was not evident. From the FGD, the farm workers were in agreement that there must be a law in place but the parent ministry or department was not known to them.

Farm workers who were trained on safe work practices were in a better position to practice safe work practices. A Chi Square test on the relationship showed that there was no significant relationship in Perkerra between being trained on safe work practices and the followings the knowledge that lifting heavy loads is likely to cause ill-health (X^2=3.392, df=12, p=0.992); the importance of reading chemical labels before handling (X^2=11.412, df=8, p=0.179); the knowledge of the consequences of not wearing PPE while handling chemicals (X^2=11.124, df=12, p=0.518); and the knowledge of the availability of PPEs in the local markets (X^2=24.602, df=16, p=0.077)

In all the three irrigation schemes, there was no significant relationship on being injured while at work and those who had been trained on safe work practices [(Ahero X2=1.346, df=4, p=0.854) (Perkerra X2=1.063, df=4, p=0.900) (MweaX2=4.240, df=4, p=0.375)]. This implied that the training that the farm workers received (if any) was not focused on accident reduction. This was confirmed during the FGD where it was reported and agreed that the trainings were conducted by chemical marketing companies.

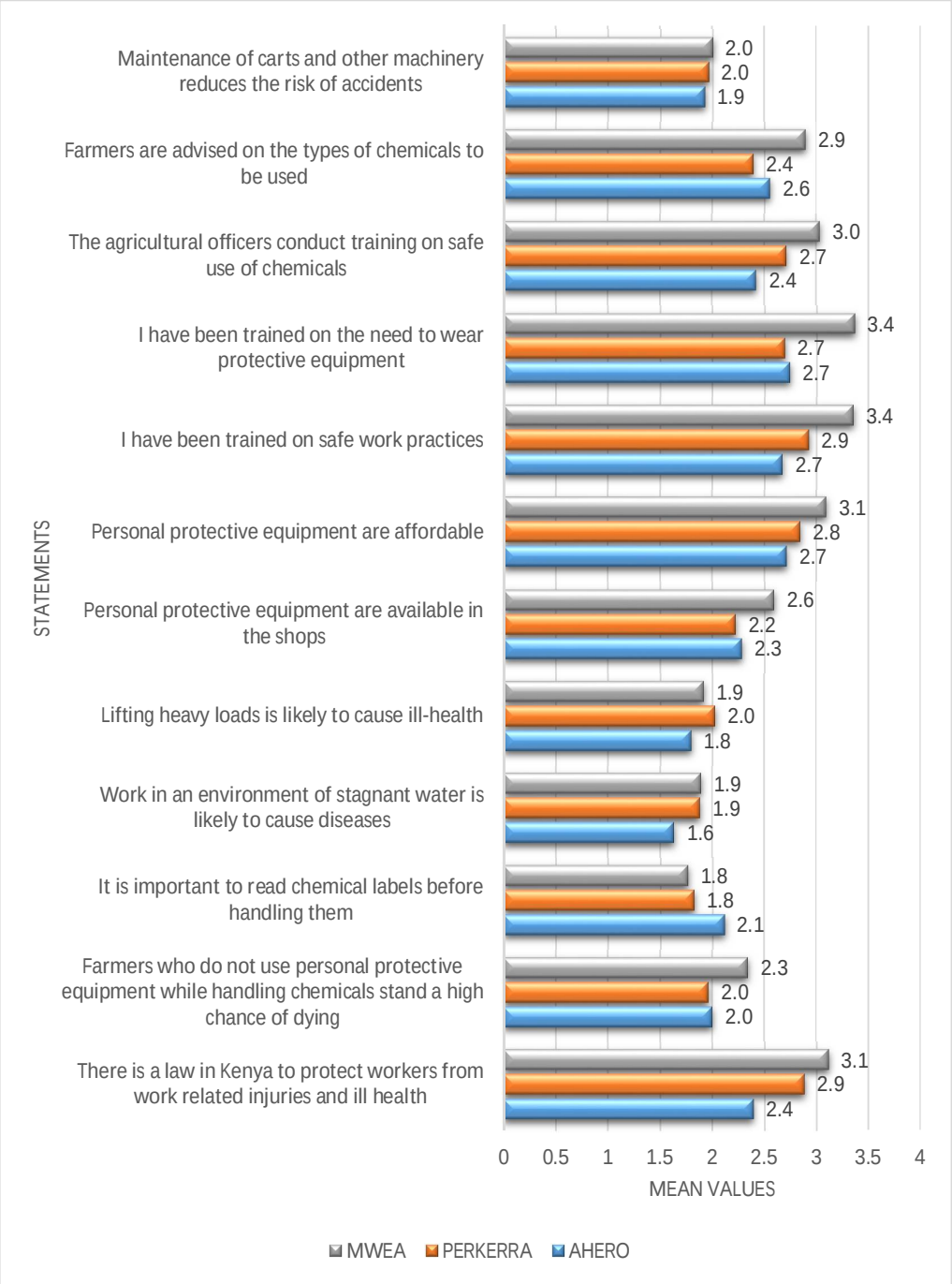


Figure 4.21: Constraints to good OSH practices in all irrigation schemes

In the FGD for the three irrigation schemes, it emerged that the farm workers were not disturbed by their unsafe behaviours, those that tasted chemicals did not believe that

the same chemical tasting can lead to their premature departure from the world. They were not able to relate the body pains to work ergonomic issues. On the issue of PPE, some farm workers did not understand that overalls and gum boots were part of protective measures. In their imagination PPE's were foreign things that were supposed to be supplied by the government or other donors. Whereas supply of drinking water was available at their residences, the farm workers did not find it necessary to carry adequate water to the farm leave alone boiling it for consumption. Among the farm workers, there were those that had an understanding of basic hygiene issues but their understanding did not translate into the way they work. For example they knew that it was necessary to boil drinking water but they claimed boiled water was tasteless hence no need to boil.

The county governments department of agriculture had officers allocated to the irrigation schemes as part of their duty. The officers concentrated their energies on food production and only brought personnel from chemical marketing companies to explain to the farm workers on the chemical type, what it does for enhanced production and how to use it. The FGD was informed that at no time did those marketing representatives ever explain the toxic nature of the chemical and how to protect themselves from their effects. Some farm workers who attended such forums were issued with branded overcoats to use while spaying the chemical while at the same time advertising them.

The incomes of the farm workers from farm produce was fairly low (Table 4.1) compared with the country's income per capita as earlier shown. That was the disposable income to feed the family, to pay for education and health of their families among other needs. The procurement of PPE's was in competition with all the other requirements of the family and was therefore ranked at the bottom among the others. Some farm workers viewed buying of PPEs as an economic burden.

4.6 The economic loss arising from the injuries and ill health

The injuries inflicted on the farmworkers and the ill health covered in the above section resulted in economic losses to the worker, the society and to the nation. The research

involved self-employed small scale irrigation farmers in public schemes hence the issue of employer does not arise and nor the issue of compensation. The worker was therefore responsible for what the employer should have provided as well as what the worker should provide.

The worker's costs comprises of both direct and indirect costs (ILO, 2012). These includes uncompensated loss of income, medical and pharmaceutical expenses, pain and suffering, inability to engage in domestic chores and loss of assets leading to diminishing resources due to unforeseen medical care expenses. It was however not within the scope of this study to estimate the cost of pain and suffering.

When a farmer is injured or ill whether in hospital or recuperating at home, farm activities must continue otherwise there will be a crop failure. Both will result into loss of earnings for the farmworker. The quality of workmanship in the farm was also likely to get affected by the absence of the farm worker arising from the injury or ill health thus lowering the production or quality hence low income. Consequently there will be money paid for replacement of labour and there was also likely loss of output loss of output.

For the purpose of this study non-fatal occupational injuries and illness were studied where the farm worker's direct costs consisted of all those for which monetary payments were made. This included payments for medical care (doctor and medicine), cost of travelling and replacement costs due to the worker being unable to carry out normal work in the farm. The cost of absence (replacement costs) was taken as the average daily wage that was paid to workers in the scheme at the time of the study.

4.6.1 Ahero irrigation scheme

4.6.1.1 Costs due to illness

In response to costs due to illness, 68.4% of the respondents replied they have been admitted to hospital with the nature of ailments being Malaria, typhoid, back pains arching bones. The lengths of indisposition was as shown in the Figure 4.22;

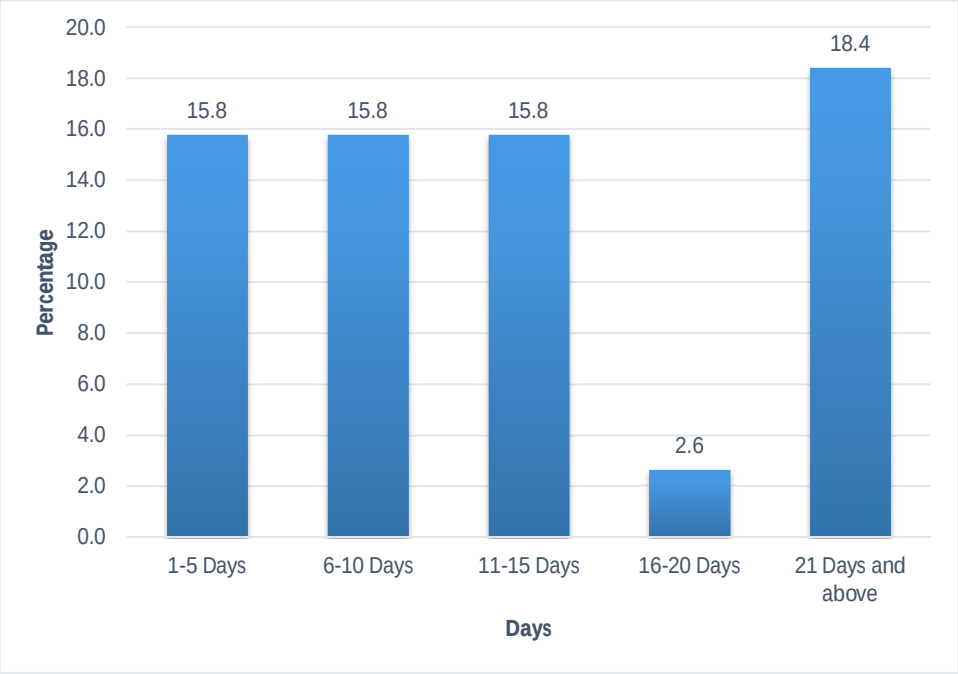


Figure 4.22: Indisposed period due to ill-health by farm workers at Ahero

The mean indisposition period for the scheme due to ill health was calculated to be 9.5 days implying that each of the 26 farm workers who were admitted to hospital lost 9.5 days within the last one year due to illness. This translates to a loss of 247 man days lost.

Using the current labour payments of Ksh 300 per worker per day,

247 x 300 = **Ksh 74,100.00**

The minimum cost of treatment in a public hospital (Ahero county hospital) was as follows

Consultation	= 300.00
Laboratory	= 100.00
Dispensing medicine	= 300.00
Admission fees	= 200.00
Inpatient fees	= 900.00

The assumption here was that the patients visited the hospital only once in the year.

Consultation before admission led to an expenditure of

= Ksh [700 x 26]

= Ksh 18,200.00

The inpatient fees amounted to

= Ksh [(200 x 26) + (26 x 9.5 x 900)]

= Ksh [5200 + 222,300]

= Ksh 227,500.00

On travelling to and from the health care unit, the average distance travelled by the farm workers was 5 km one way which translated to transport charges of Ksh 100.00 return by local taxis (bodaboda).

Total transport cost was therefore Ksh 26 x 100 = **Ksh 2,600.00**

Total hospital attendance expenses = [replacement labour cost + hospital fees + hospitalization fees + transportation fees]

= [74,100.00 + 18,200.00 + 227,500.00 + 2,600.00]

= Ksh 322,400.00

4.6.1.2 Costs due to injuries

In Ahero, a total 34 respondents (89.5%) reported that they were injured in the cause of work. Those injured were indisposed for an average of 3 days of which 40% were treated in hospital translating to loss of 102 days due to occupational injuries. Out of the 34 injured, 19 (55.9%) farmworkers were treated in hospital with 4 getting hospital admission while another 15 (44.1%) treated themselves at home as shown in the Figure

4.23. Finnegan, 2008 reported that 80% of the ailments in Ireland required treatment in hospital.

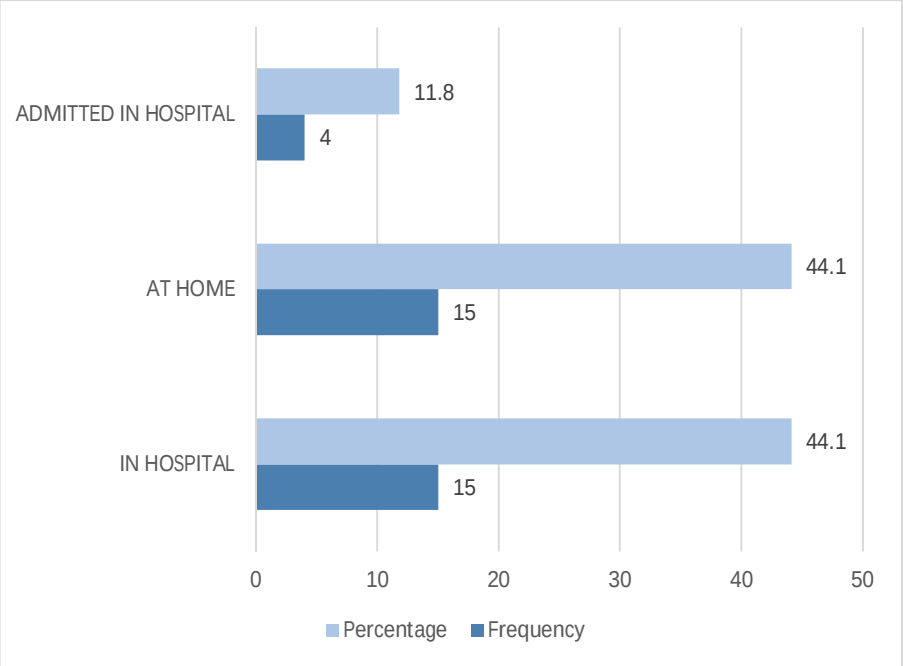


Figure 4.23: Methods of injuries treatment at Ahero

The lost work days amounting to 102 days had labour replacement cost

= 102 x 300 = **Ksh 30,600.00**

The farm workers admitted at the hospital paid Ksh [(4 x 700) + (200 x 4) + (4 x 3 x 900)

Laboratory fees will be substituted for dressing of the wound

= Ksh 14,400.00

The farm workers who were treated at the hospital but discharged paid Ksh (15 x 700)

= Ksh 10,500.00

The farm workers who treated themselves at home bought pain killers and other medication at an assumed average cost of Ksh 200.00 leading to an expenditure of 15 x 200 amounting to

= Ksh 3,000.00

Transport cost for the injured workers paid Ksh 34 x 100 for taxi return fare

= Ksh 3,400.00

Total cost due to injuries is therefore Ksh [30,600 + 14,400.00 + 10,500 + 3000 + 3,400]

= Ksh 61,900.00

4.6.1.3 Economic loss at Ahero irrigation scheme

The direct losses incurred at Ahero irrigation scheme by the farm workers amounted to

Loss due to injuries + loss due to ailments

= Ksh (61,900.00 + 322,400)

= **Ksh 384,300.00** from a sample size of 38

When extrapolated to a population of 946 plot holders, this translates to an economic loss of **Ksh 9,567,047.00 per year**

The amount of money paid to the Ahero irrigation scheme plot holders in 2015/16 year was Ksh 157,000,000.00 (KNBS Statistical abstract, 2017). The loss was therefore 6.1% of the money earned by farm workers at the Ahero irrigation scheme. This loss does not include the contribution of the governments to the health care and other indirect losses to both the governments and the farm worker.

4.6.2 Perkerra irrigation scheme

4.6.2.1 Costs due to illness

Farm workers at Perkerra irrigation scheme were asked to state if they had been admitted to hospital within the last 12 months to which 12 persons (24.5%) responded in the affirmative. The nature of ailments that facilitated admissions included Malaria, typhoid and bilharzia. The average indisposition period for those admitted was 7 days resulting to a loss of 84 work days due to illness as shown in Figure 4.24.

Using the current labour payments, this translates to a labour replacement cost of Ksh
84 x 300 = **Ksh 25,200.00**

Over 58% of the respondents were treated at Marigat sub county hospital while the rest were being attended at Lingarua health centre both of which were under the county government of Baringo. The method of charge at Marigat sub county hospital was not very clear and hence estimation shall be based on the charges incurred at a similar facility at Ahero.

Hospital charges shall be [(12 x 700.00) + (12 x 200) + (12 x 900.00 x 7) = **Ksh. 86,400.00**

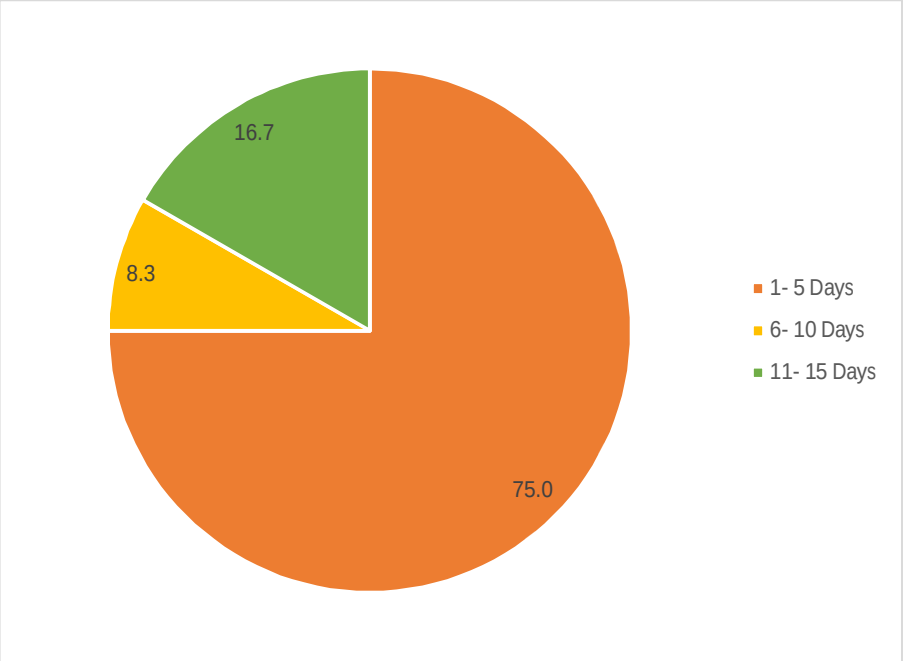


Figure 4.24: Indisposed period for Perkerra farm workers

The cost of transportation to and from the health care centre was by means of the local taxis (bodaboda) with a charge of Ksh 100.00 for a distance averaging 5 kilometres. Total transport cost was therefore Ksh (12 x 100.00) = **Ksh 1,200.00**

Total hospital expenses due to illness therefore amounted to

Ksh. [25,200.00 + 86,400.00 + 1,200.00]

= Ksh 112,800.00

4.6.2.2 Costs due to injuries

When the respondents at Perkerra were asked to state if they had ever been injured while at work, 98% (48) replied that indeed they have been injured severally with the majority of the injuries reported to be from tools with an average number of days for indisposition being 2.5. This translated to a loss of 120 work days.

Out of the 48 injured, only one was admitted to hospital, 37 were treated and discharged in hospital while 10 treated themselves at home (Fig 4.25).

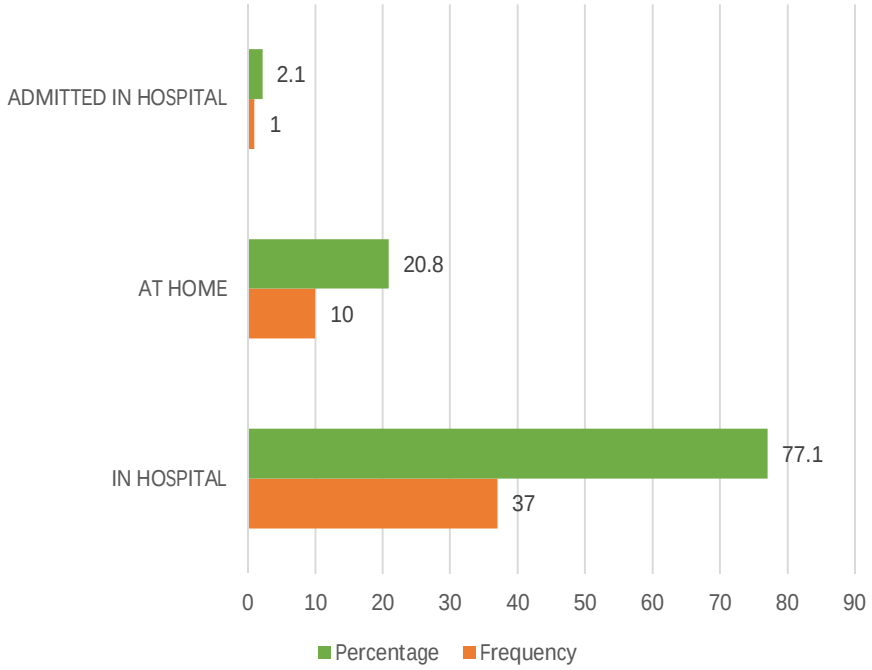


Figure 4.25: Methods of injuries treatment at Perkerra

Labour replacement cost for the injured amounted to Ksh (120 x 300)

= Ksh 36,000.00

The farm worker who was admitted in hospital paid Ksh (1 x 700) + (1 x 200) = (1 x 2.5 x 900)

= Ksh 3,150.00

The farm workers treated and discharged from the hospital paid Ksh (37 x 700)

= Ksh 25,900.00

Transport return costs for the injured farm workers were Ksh (48 x 100)

= **Ksh 4,800.00**

Those that treated themselves at home spent Ksh (200 x 10) = **Ksh 2,000.00**

The total cost due to injuries was Ksh [36,000.00 + 3,150.00 + 25,900.00 + 4,800.00 + 2,000]

= Ksh. 71,850.00

4.6.2.3 Economic loss at Perkerra irrigation scheme

The total direct cost incurred at Perkerra irrigation scheme by the farm workers in one year due to injuries and ill health amounted to Ksh 112,800.00 + 71,850.00

= Ksh 184,650.00 from a sample size of 49 farm workers

When extrapolated to a population of 1221 plot holders, this translates to an economic loss of Ksh 4,601,177.00 in a year.

The amount of money paid to Perkerra irrigation scheme plot holders for the year 2013/14 was Ksh 112,000,000.00 (KNBS Statistical abstract 2017)

The loss was therefore 4.1% of all the money earned from farm work exclusive of the indirect losses and expenditure of the county and central government on provision of medical services.

4.6.3 Mwea irrigation scheme

4.6.3.1 Costs due to illness

Farm workers were asked to state whether they have been admitted to hospital where 32.1% of the respondents replied positively with the nature of ailments being Malaria, bilharzia, typhoid, back pains arching bones. The lengths of indisposition was as shown in the Figure 4.26 with a mean value of 9 days. This implied that each of the 93 farm workers spent 9 days in hospital resulting to 837 lost work days.

The replacement labour cost was therefore 93 x 9 x 300 = **Ksh 251,100.00**

About 47% of the respondents sought for medical attention at the government health care centres that included Kimbimbi Sub County hospital, Nguka, Kandongu, Thiba and Mutithi health centres while the rest attended privately operated health care centres.

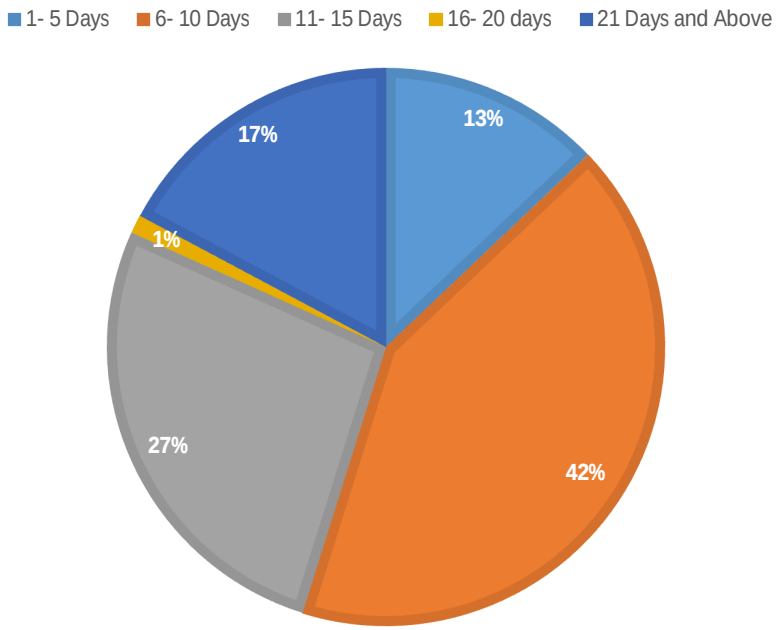


Figure 4.26: Period of indisposition due to hospital admission Mwea

Assuming a rate similar to the government hospital, hospital charges would amount to:

Ksh [93 x 700] + [93 x 200] + [900 x 93 x 9] = **Ksh. 837,000.00**

Farm workers travelled a mean distance of 5.5 km to reach health care centre of their choice whether government or private operated. For them to reach there and back by means of bodaboda, they spent Ksh 100.00 each.

Total transport cost in Mwea was therefore Ksh 100 x 93 = **Ksh 9,300.00**

The total hospital expenses due to illness = 251,100.00 + 837,000.00 + 9,300.00

= **Ksh 1,097,300.00**

4.6.3.2 Costs due to injuries

At Mwea irrigation scheme, a total of 265 respondents (91.1%) reported that they have been injured while working by either tools, machinery or other implements. Those injured were indisposed for an average of 1 day only. A total of 265 days were therefore lost due to the injuries.

Labour replacement cost therefore amounted to 265 x 1 x 300 = **Ksh 79,300.00**

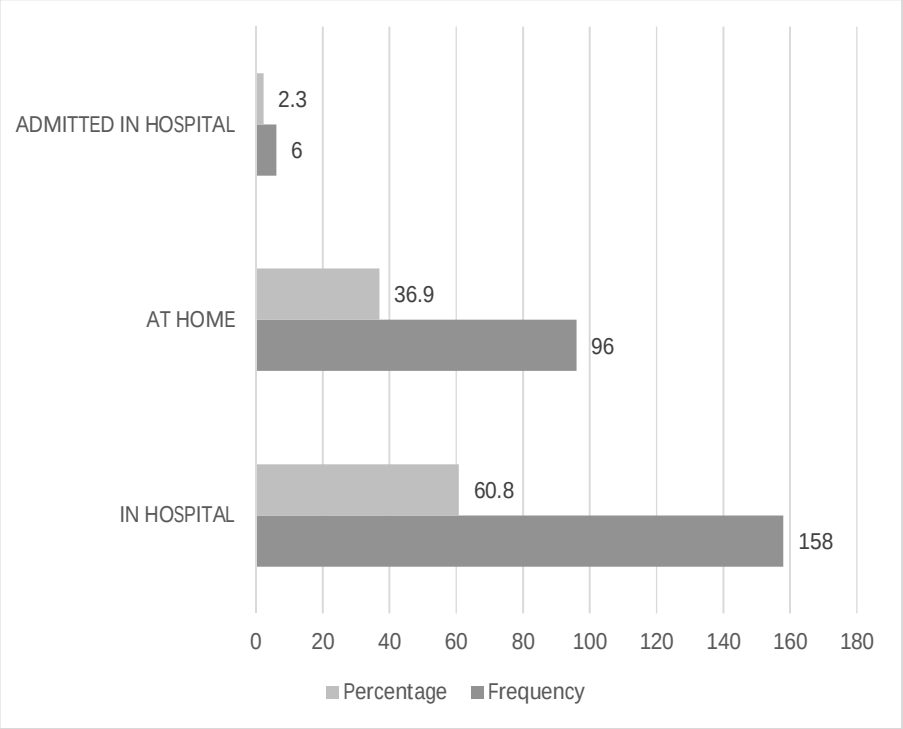


Figure 4.27: Methods of injuries treatment at Mwea irrigation scheme

Only 6 respondents (2.3%) were admitted in hospital due to work related injuries (Figure 4.27). These farm workers paid Ksh (6 x 700) + (6 x 200) + (6 x 900 x 1)

= **Ksh 10,800.00**

The farm workers treated in hospital and discharged paid Ksh (158 x 700)

= **Ksh 110,600.00**

Those who treated themselves at home spent an average of Ksh 200 each amounting to a total spend of Ksh (96 x 200) = **Ksh 19,200.00**

Transport cost for the injured workers to health care centres or to procure medication amounts to Ksh 265 x 100 = **Ksh 26,500.00**

Total cost due to injuries will therefore be

Ksh (79,300.00 +10,800.00+110,600.00+19,200.00+26,500.00)

= **Ksh 246,400.00**

4.6.3.3 Economic loss at Mwea irrigation scheme

The economic loss incurred at Mwea irrigation scheme due to injuries and ill health amounted to Ksh (1,097,300 + 246,400.00)

= Ksh 1,343,700.00 for a population of 293 farm workers

When extrapolated to a population of 7,178 plot holders, this translates into an economic loss of Ksh 32,918,357.00 per year due to injuries and ill health with each farm worker (plot holder) incurring a loss of Ksh 4,586.00 in a year.

The amount of money paid to the Mwea irrigation scheme plot holders for the year 2015/16 year was Ksh 3,938,000,000 (KNBS Statistical abstract 2017).

The economic loss can therefore be quantified as 0.84% of the money earned from farm work. Indirect losses and other inputs from the governments have not been factored in these calculation estimates.

4.6.4 Economic loss for the public irrigation schemes

The summary of the economic losses is as shown in Table 4.7. Tabulation of sample size, population, earnings have been computed together with the calculated losses due to illness and injuries. The total for the sample has been extrapolated to full scheme population giving rise to the percentage of total earnings that have been lost due to injuries and ill health. The figures given at this stage covers only direct costs that have been paid by the farm worker leaving out all the indirect losses that includes productivity and other costs incurred by the society and the governments (national and county).

Table 4.7: Economic loss at the public irrigation schemes in Kenya

	Ahero	**Perkerra**	**Mwea**	**All public schemes in Kenya**
Sample size	38	49	293	380
Population	946	1,221	7,178	13,055
(2015/2016) Earnings (2015/2016)	9,567,047.00	112,000,000.00	3,938,000,000.00	4,591,000,000.00
Ill health	322,400.00	122,800.00	1,097,300.00	
Injuries	61,900.00	71,850.00	246,400.00	
Total for sample	384,300.00	184,000.00	1,343,700.00	1,912,000.00
Total for scheme (extrapolation)	9,568,047.00	4,601,177.00	32,918,357.00	65,780,130.00
% of earnings	6.1	4.1	0.84	1.43

Figure 4.28 below gives a representation of the earnings in each irrigation scheme with corresponding economic losses all in Kenya shillings, losses also given in percentages with error bars

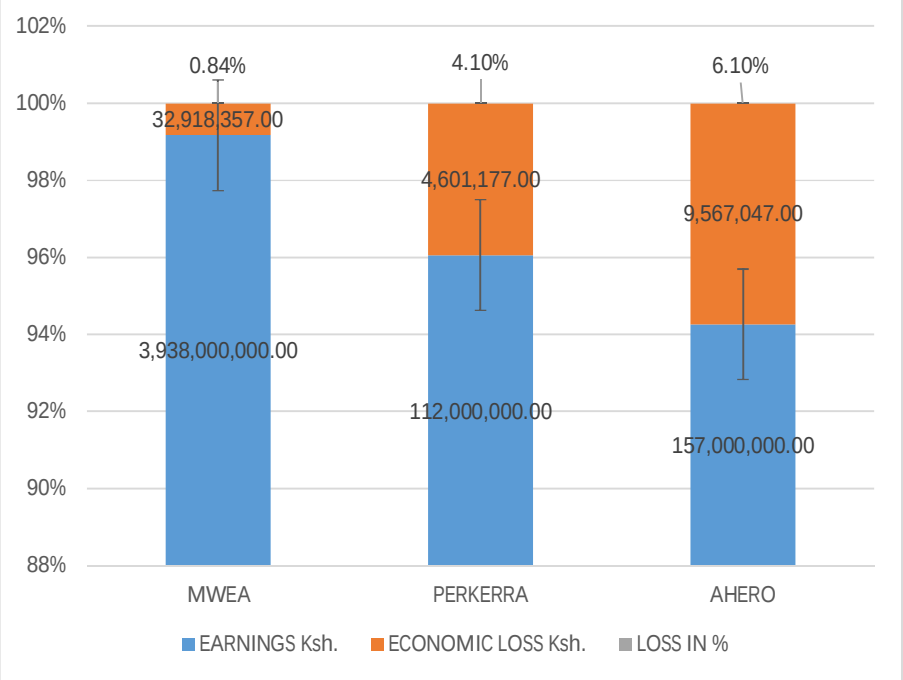


Figure 4.28: Economic losses due to injuries and ill-health

The total economic loss in all the three public irrigation schemes was calculated to some Ksh 47,086,581.00 for a sample size of 380 respondents and a population of 9,345 farm workers. When extrapolated to the total population in all the public irrigation schemes of 13,055 plot holders, this amounts to a loss of Ksh 65,780,130.00 in a year which was 1.43% of the total income.

The overall economic loss of 1.43% was foreseeable considering that the ILO estimates an average economic loss of 4%. In Kenya the economic loss was expected to be much higher considering that Kenya is a developing nation that does not have good structures for managing Occupational safety and health issues. Indirect costs for both the farm worker and the government and community have not been taken into account as well as fatal accidents.

The Australian government (Australian Government, 2009) estimated that only 25% of the total cost of work related injury and disease was due to direct costs with the balance being indirect costs such as loss of productivity, loss of income, and quality of life. If this were to be applied, then total loss would amount to **Ksh 263,120,520.00 equivalent to 5.7%** of all the earnings of all the irrigation schemes in Kenya excluding costs of fatalities.

4.7 Intervention measures for the control of injuries and ill health

The intervention was carried out in one of the irrigation schemes namely Mwea for effectiveness and visibility. Mitigation measures were developed based on the hierarchy of controls principle and addressing best practices for prevention of injuries in addition to prevention of key diseases that affected the farm workers. Majority of the accidents occurred to the leg as earlier shown in Figure 4.12.

A cross tabulation of injury causes and injured body parts (Table 4.8) shows that majority of the injuries to the hand were from use of tools while majority of injuries to the leg originated from use of tools and the cart. In Mwea irrigation scheme, the jembe (hoe) was the most widely used tools closely followed by the panga (machete) as illustrated in Figure 4.8. The use of the two tools was likely to have an impact on either the leg or the hand as far as injuries are concerned.

A cross tabulation of the injured body part with indisposed period revealed that leg injury resulted to the highest LWC with 98 farm workers having 3 days and above lost workday cases as shown in Table 4.9. The hand also had a significant lost workday case with 15 farm workers having above 3 LWC. This results demonstrated the need to develop a focussed intervention to reduce the leg and the hand injuries among others.

Table 4.8: Cross-tabulation of Body parts injured and the injury agents at Mwea

			Injury causes					Total
			MACHINE	CART	TOOLS	LIFTING LOAD	FALL FROM HEIGHT	
Body part injured	HAND	Freq	1	2	30	2	1	36
		%	0.4%	0.8%	11.4%	0.8%	0.4%	13.6%
	LEG	Freq	0	23	179	2	1	205
		%	0.0%	8.7%	67.8%	0.8%	0.4%	77.7%
	BACK	Freq	0	5	10	2	0	17
		%	0.0%	1.9%	3.8%	0.8%	0.0%	6.4%
	HEAD	Freq	0	2	4	0	0	6
		%	0.0%	0.8%	1.5%	0.0%	0.0%	2.3%
Total		Freq	1	32	223	6	2	264
		%	0.4%	12.1%	84.5%	2.3%	0.8%	100.0%

Table 4.9: Cross-tabulation of Body parts injured and indisposed period

			Indisposed Period			Total
			1 DAY	1-2 DAYS	3 DAYS AND ABOVE	
Body part injured	HAND	Freq	8	12	15	35
		%	3.1%	4.6%	5.8%	13.5%
	LEG	Freq	69	35	98	202
		%	26.5%	13.5%	37.7%	77.7%
	BACK	Freq	6	3	8	17
		%	2.3%	1.2%	3.1%	6.5%
	HEAD	Freq	4	1	1	6
		%	1.5%	.4%	.4%	2.3%
Total		Freq	87	51	122	260
		%	33.5%	19.6%	46.9%	100.0%

In the case of ill health, the highest exposure hazards was biological hazards closely followed by physical hazards, chemical hazards and ergonomic hazards. In the diseases report from the health care providers, URTI was leading at 46.3% with skin diseases at 9.6% and diarrhoea ailments at 8.6% (Fig 4.17). The focus of the intervention was therefore based on ways and means of reducing the impact of URTI, skin diseases and gastrointestinal disorders. Knowledge on chemicals was therefore imparted alongside those of other dusts that were identified at the workplace since chemicals have a contribution on the URTI and skin ailments. Each of the 40 farm workers in the programme was issued with dust masks and trained on how to use them. The farm workers were also trained on suitable personal protective equipment and clothing to cater for leaking knapsacks and other contact of skin with chemicals. Table 4.10 gives an outline of the measures that were developed to mitigate the hazards with a view to reduce the vulnerability of the farm workers. Measures to address ergonomic and physical hazards have also been included in the table.

Table: 4.10: Mitigation matrix for the control of injuries and ill health

Activity	Hazards	Risk description	Control measure
LAND PREPARATION	Machinery	Injury from machines	Training
	Tools	Injury from tools	Training Use of suitable tools Proper handling of tools
	Chemicals	Illness from dermal, inhalation and ingestion of chemicals	• Training on good practice handling and storage • Read chemical labels before use and handling • Wear appropriate PPE's
	Animals	Injury and exposure to zoonosis disease	Proper animal handling Vaccination to both animal and handler

	Drinking water and sanitation	Ill health – exposure to water borne diseases	• Boil drinking water Provision of toilet facilities
	Organic dust	Ill health	Wear respirator or dust mask (PPE)
	Hot direct sun	Dehydration that may lead to heat stroke	Drink water every 15 minutes, even when not thirsty. Wear a hat and light - coloured clothing. Rest in the shade if available.
PLANTING	Tools	Injury from tools	Training Use of suitable tools Proper handling
	Chemicals	Illness from dermal, inhalation and ingestion of chemicals	Training on good practice handling and storage Read chemical labels before use and handling Wear appropriate PPE's
	Drinking water and sanitation	Ill health – exposure to water borne diseases	Boil drinking water Provision of toilet facilities
	Postures	Awkward postures when planting	Training Taking periodical rest
	Insects	Illness / Exposure to blood sucking pests	Use insect repellent
	Wet environment	Illness	Wear appropriate shoes and clothing Keep warm
	Drinking water and sanitation	Ill health – exposure to water borne diseases	Boil drinking water Provision of toilet facilities
WEEDING	Postures	Musculoskeletal disorders	Training Taking periodical rest
	Chemicals	Illness from dermal, inhalation and ingestion of chemicals	Training on good practice handling and storage Read chemical labels before use and handling

			Wear appropriate PPE's
	Tools	Injury from tools	Training Use of suitable tools Proper handling
	Wet environment	Illness	Wear appropriate shoes, gloves and clothing Keep warm
	Drinking water and sanitation	Ill health – exposure to water borne diseases	Boil drinking water Provision of toilet facilities
	Insects	Illness / Exposure to blood sucking insects	Use insect repellents
CROP HUSBANDRY	Chemicals	Illness from dermal, inhalation and ingestion of chemicals	Training on good practice handling and storage Read chemical labels before use and handling Wear appropriate PPE's
	Wet environment	Ill health – exposure to water borne diseases	Wear appropriate shoes and clothing Keep warm
	Hot direct sun	Dehydration that may lead to heat stroke	Drink water every 15 minutes, even when not thirsty. Wear a hat and light - coloured clothing. Rest in the shade if available.
	Drinking water and sanitation	Ill health – exposure to water borne diseases	Boil drinking water Provision of toilet facilities
	Pollen dust	Ill health	Wear respirators
	Posture	Musculoskeletal disorders	Training
HARVESTING AND TRANSPORTATION	Machinery	Injury from machines	Training
	Tools	Injury from tools	Training Use of suitable tools Proper handling of tools
	Lifting weights	Musculoskeletal disorders	Training

	Postures	Musculoskeletal disorders	Training
	Hot direct sun	Dehydration that may lead to heat stroke	Drink water every 15 minutes, even when not thirsty. Wear a hat and light - coloured clothing. Rest in the shade if available.
	Drinking water and sanitation	Ill health - exposure to water borne diseases	Boil drinking water Provision of toilet facilities
	Cart	Injury from animal driven carts Exposure to zoonosis diseases	Proper maintenance of the cart Training on operations of the cart Proper animal handling Vaccination to both animal and handler

After going through the mitigation measures with the 40 farm workers, and after practicing for one crop cycle, the farm workers were tested on their understanding of occupational safety and health issues that led to injuries and ill health. Figure 4.29 gives the results as reported by the respondents and comparing the results with the scores before the intervention.

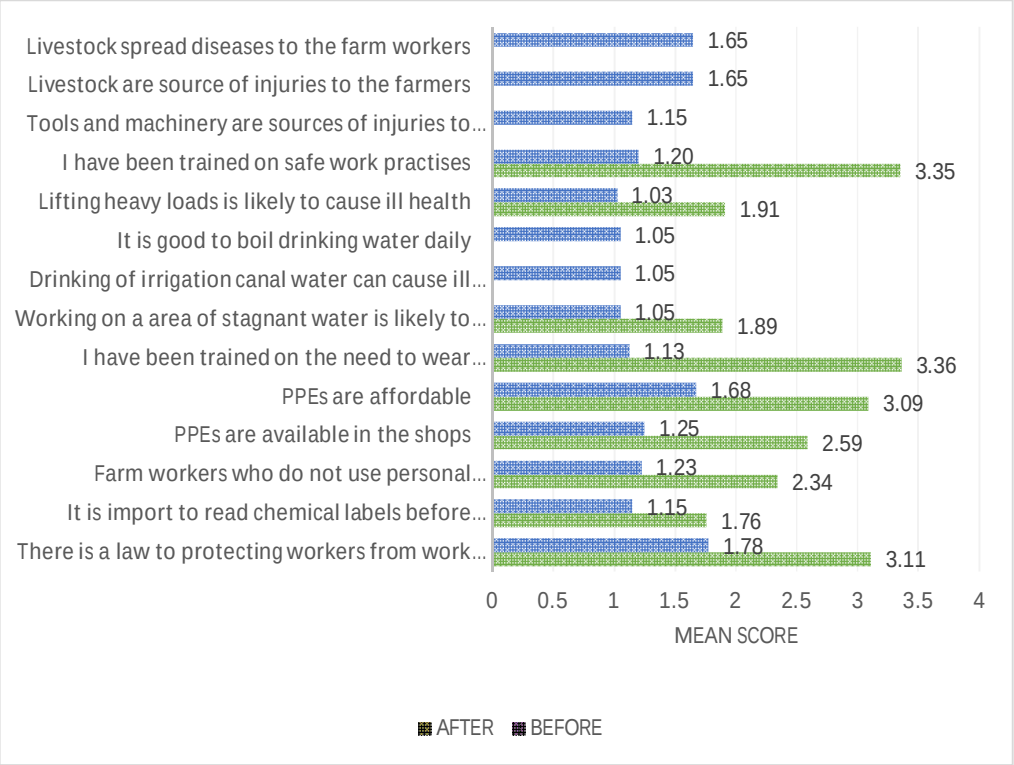


Figure 4.29: Level of knowledge on OSH before and after intervention

After training, farm workers had improved the mean score from 3.36 to 1.13 on the need to wear PPE's, while training on safe work practices improved from 3.35 to 1.20. Knowledge on the availability of a law to protect workers from injuries and ill health, the mean value improved from 3.11 to 1.78 while availability of PPEs improves from 3.09 to 1.68. Farm workers were not aware before intervention that overalls, masks, gloves etc were necessary and believed they were an economic burden hence could not buy them. With the understanding on the repercussions on non-wearing, the usage increase as the crop cycle progressed. Figure 4.29 shows that there was a general improvement on understanding, knowledge and practice in all areas covered by the intervention which was very encouraging to the researcher. There was an overall attitude change to the protection of the body from hazards at the workplace towards the close of the study from among the 40 who went through the intervention. The outcome of the intervention gave similar results to the one carried out in Canada (Kim,

Arrandale, Kudia, Mardell & Holness, 2012) and Thailand (Buranatrevedh & Sweatsriskul, 2005).

The Table 4.11 shows the steps that were followed in the training for the achievement of the results that were obtained and presented in Figure 4.29.

Table 4.11: Steps followed in the intervention.

	Steps	**Remarks**
1	Link up with the scheme management	NIB
2	Link up with water distribution committee at the scheme	IWUA
3	Identify the blocks to be covered by the training and their IWUA leaders	It's good to concentrate on a defined area for purposes of monitoring and follow up
4	Carry out preliminary survey	Preliminary survey is a prerequisite
5	Identify the key issues to be addressed in the training through a risk assessment and focus group discussion	Focus on a few key issue at a time
6	Identify the person to be trained	It is important to train the plot holder than employees
7	Planning of improvement proposals with key personnel	The key personnel will later act as assistant trainers
8	First meeting to address the objectives and deliverables	Make it short – 1 hour
9	Get to understand the calendar of activities at the scheme	Plan training on a period of less activity in the farms
10	Plan schedule of theoretical training	Training to cover a full crop cycle

11	Develop participative approach using locally available and cheap materials. You may require some locals to help in training	Locally developed is easily accepted and cheaper to implement as opposed to one that is imposed
12	Every theoretical training should be accompanied by a practical approach. Each day not more than half day	The farm workers have their personal work to attend to every day
13	Maximum time for theoretical training is 2 hours	Farm workers easily get bored and could sleep
14	Follow up to implement the learnings practically on the farms	Visit farm workers in their farms when they are busy to see if they are applying the knowledge acquired.
15	Keep records	Keep record of training attendance and photos/video of the farm workers

The intervention adopted a model developed by Hasle and Limbog in 2006, modified to suit the purpose as shown in Figure 4.30.

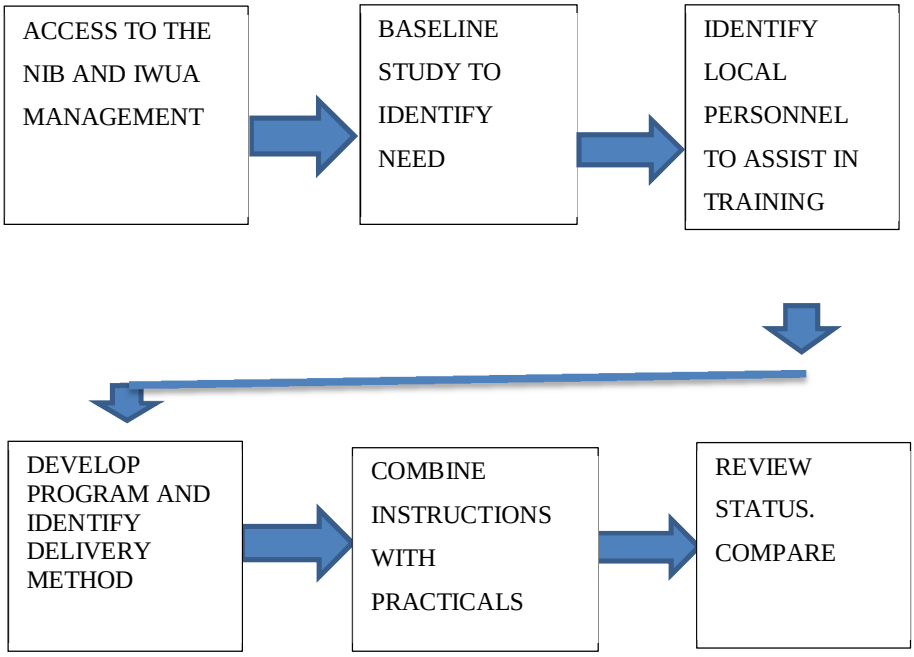


Figure 4.30: Intervention model used at Mwea irrigation scheme.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 Significant safety and health hazards encountered by irrigation farm workers

Farm workers were exposed to biological, chemical, ergonomic and physical hazards in all the irrigation schemes. Biological hazards were the most significant in all the schemes caused by blood sucking pests, livestock keeping, poor sanitation in the farm and scarcity of clean drinking water in the fields. Chemicals were used in almost all stages of production and therefore constituted a high level of hazards. There was no organization or government body that advised the farm workers on the safe agrochemicals to use. This exposed farm workers to harm since widespread and uncontrolled use of these chemicals may result in many short term and long term health effects to the farm workers. High temperature coupled with work in a wet environment and poor ergonomics were major challenges to the farm workers.

5.1.2 Significant work related injuries and ill-health

Majority of injuries occurred on the leg and the hand in all irrigation schemes. The leg had the highest indisposed period leading to high Lost Workday Cases (LWC) in all the irrigation schemes. The key causative agents for the injuries were mainly farm tools and machinery in all the schemes.

i. All farm workers have a high vulnerability to injuries irrespective of age, or gender.
ii. Work in farms have a high prevalence of injuries (wounds) when compared with the national statistics.
iii. Ahero had more cases of Malaria, Skin diseases, Diarrhea and Pneumonia while Mwea had high cases of URTI, Skin diseases, Diarrhea and Pneumonia that were above the national average.

5.1.3 Constraints that hinder good OSH practices

Good occupational safety and health practices was hindered by

i. Lack of education and training with a focus on safety and health issues in terms of quality and reach (Inadequate for the purpose).
ii. Economic and cost related issues, vis-a-vis competing priorities
iii. Lack of support from government agencies whose presence was not being felt on the ground – DOSHS and Ministry of Agriculture.
iv. Farm workers knowledge of safety and health and preventative measures.

5.1.4 Economic losses incurred by farm workers

Farm workers in Ahero lost about 6.1% of their income due to injuries and ill health while those at Perkerra lost 4.1% of their income and those in Mwea lost 0.84% of their income. The overall loss amounted to Ksh 65,780,130.00 equivalent to 1.43% of all the earnings from all the irrigation schemes in Kenya excluding the cost of fatalities.

i. The economic losses were a threat to eradication of poverty and achievement of food security and vision 2030 as envisaged by the Government of Kenya.
ii. The economic loses could have been avoided by practicing good OSH practices and therefore reducing the LWC.

5.1.5 Intervention

There was a high improvement after intervention was carried out in Mwea irrigation scheme among the 40 farm workers in the understanding and perception of safety and health. Based on the results, it can be deduced that practical and locally developed education and trainings are the two basic strategies that can be applied in the public irrigation schemes (small scale) in Kenya to mitigate occupational injuries and ill health.

5.2 Recommendations

i. Training on identification of occupational safety and health hazards and development of control measures to the farm workers should be prioritized using the ILO participatory approach tool – WIND (Work Improvement in Neighbourhood Development). Practical training specific to farm workers and delivered in their work environment is likely to have a lasting culture change in the way they work.
ii. Future agricultural practice should focus on reducing chemical dependency syndrome that includes fertilizers and agrochemicals. The hierarchy of controls principle to be effected sequentially
iii. Selection and spaying of chemicals should be conducted centrally by the county government or scheme management to reduce the number of chemical handlers and avoid use of highly toxic chemicals as was the case stated in section 13 of the Irrigation (National Irrigation Schemes) Regulations 1977.
iv. Mechanization of agriculture through NIB, IWUA or farmers' cooperative societies would result in reduction of the ergonomic hazards drastically
v. The County government should ensure adequate clean drinking water and proper sanitation at the farms
vi. The Ministry responsible for occupational safety and health should develop guidelines and standards on occupational safety and health in agriculture.

Further research

i. Ergonomic risk factors and health effects in irrigation agriculture at Mwea irrigation scheme, Kenya.
ii. Development of suitable ergonomic farm tools to be used by farm workers in Kenyan irrigation schemes.
iii. The impact of occupational safety and health intervention in small scale agriculture.
iv. Effect of mechanization in agriculture to the occupational safety and health of the farm workers

v. Work related injuries and ill health among farm workers in large scale farming in Kenya

REFERENCES

Athi Water Services Board. (2014). *Mwea - Makima water supply system in Tana water services board*. Nairobi.

Australia Safety and Compensation Council. (2009). *The cost of work-related injury and illness for Australian employers, workers and the community.* Australia Government.

Australian Government. (2009). *The cost of work related injury and illness for Australian employers, workers and the community.* Australian Safety and compensation Council.

Behroozy, A., & keegel, T. G. (2014). Wet-work exposure: A main risk factor for occuational hand dermatitis. *Elsevier: Safety and Health at Work.*

Boischio, A., Clegg, A., & Mwagore, D. (2006). *Health risks and benefits of urban and peri-urban agriculture and livestock in Sub-Saharan Africa.* IDRC.

Buranatrevedh, S., & Sweatsriskul, P. (2005). Model development for health promotion and control of agricultural occupational hazards and accidents in Pathumthani, Thailand. *Industrial Health*, 669-676.

Cakmur, H. (2014). Health risks faced by Turkish Agricultural workers. *The Scientific World Journal.*

Centers for Disease Control and Prevention. (2014). *Agricultural safety.* Atlanta: www.cdc.gov/niosh.

Chattha, H. S., Corscadden, K. W., & Zaman, Q. U. (2017). Hazard identification and risk assessment for improving farm safety on Canadian farms. *Journal of Agricultural safety and health*, 23 (3): 155 - 174.

Christensen, K., Harper, B., Luukinen, B., Buhl, K., & Stone, D. (2010, April). *Chlorpyrifos General Fact Sheet, National Pesticide Information Centre.*

Retrieved from Oregon State university Extension Services: http://npic.orst.edufactsheets/chlorpgen.html

Day, L. M., Cassel, E., Li, L., & A, M. (1999). *Preventing Farm injuries: Overcoming the barriers. A report for the rural industries research and development corporation.* Monash University www.monash.edu.au.

DOSHS. (2017). *Annual report 2015 - 2016*.

Environmental Protection Agency. (2017). *Chemicals Evaluated for Carcinogenic Potential* . Office of Pesticide Programs.

FAO/IFC. (2015). *Kenya, Irrigation market brief.* Rome: Food and Agriculture Organization.

Fathallah, F. A. (2010, 3). Musculoskeletal disorder in labour-intensive agriculture. *Applied Ergonomics 41*, 738-743. Retrieved from Applied Ergonomics.

Finnegan, A. (2007). *An examination of the status of health and safety on Irish farms.* Dublin: PhD Thesis, National University of Ireland .

Forastieri, V. (1999). *The ILO programme on occupational safety and health in agriculture.* www.ilo.org/safework

Garrard, C. (1998). Farmers occupational health health: cause for concern, cause for action. *Journal of advanced nursing*, 155 - 163.

Gervais, J. A., Luukinen, B., Buhl, K., & Stone, D. (2010, April). *Imidacloprid Technical Fact Sheet, National pesticide Information Centre.* Retrieved from Oregon State University Extension Services: http://npic.orst.edu/factsheets/archive/imidacloprid.html

GOK. (2007). *Kenya Vision 2030. A globally competitive and prosperous Kenya.* Nairobi: Government of Kenya.

GOK. (2009). *Food security in Kenya.* Nairobi: Ministry of Agriculture.

GOK. (2010). *Agriculture sector development strategy 2010 - 2020.* Nairobi: www.kilimo.go.ke

GOK. (2010). *Economic review of Agriculture* . Nairobi: www.kilimo.go.ke.

GOK. (2015). *Economic Review of Agriculture 2015.* Nairobi: GOK.

Hamalainen, P., Takala, J., & Kiat, T. B. (2017). *Global Estimates of Occupational Injuries and Work-related illness 2017*. Singapore: Workplace Safety and Health Institute.

HSE. (2012). *Cost to Britain of workplace injuries and work related ill health: 2010/11 update.* www.hse.gov.uk accessed on 15/1/2015.

HSE. (2017). *Health and safety in Agriculture, forestry and fishing sector in Great Britain.* Retrieved from Health and Safety Executive: www.hse.gov.uk/statistics/

HSE. (2018). *Heat stress*. Retrieved from Health and Safety Executive: www.hse.gov.uk/temperature/heatstress/index.htm

HSE (2018). Agriculture health and safety. Retrieved from http://www.hse.gov.uk.

Hurst, P., Termine, P., & karl, M. (2005). *Agricultural workers and their contribution to sustainable agriculture and rural development.* www.fao-ilo.org

ILO. (2000). *Safety and health in agriculture.* Geneva: Safework www.ilo.org

ILO. (2000). *Safety and health in agriculture.* Geneva: SafeWork.

ILO. (2001). *C184 - Safety and health in Agriculture convention.* www.ilo.org

ILO. (2002). *Introductory report: Desent work - safe work XV1th world congress on safety and health at work.* Vienna: www.ilo.org.

ILO. (2003). *Decent work in agriculture.* Geneva: ILO.

ILO. (2005). *Introductory report: Decent work - safe work. XV11th world congress on safety and health at work.* Orlando: www.ilo.org.

ILO. (2010). *Code of practice on safety and health in agriculture.* Geneva: www.ilo.org.

ILO. (2012). *Estimating the economic costs of occupational injuries and illnesses in developing countries:Essential information for decision - makers.* Geneva: ILO.

ILO. (2013). *National profile on occupational safety and health, Kenya.* www.ilo.org.

ILO. (2014). *Global Action Guide for WIND (Work Improvement in Neighbourhood Development) Practical approaches for improving safety, health and working conditions in agriculture.* Geneva: International Labour Office.

ILO. (2014). *Global Action Guide for Wind: Work Improvement in Neighbourhood Development/Practical approaches for improving safety, health and working conditions in agriculture;.* Geneva: International Labour Office.

IPCS. (2017). *International Chemical Safety Cards (ICSCs).* Retrieved from IPCS INCHEM: www.inchem.org

Israel, G. D. (1992, Nov). Determining sample size. *University of Florida. Fact Sheet PEOD - 6.* Retrieved from University of Florida.

Karunamoorthi, K., Mohammed, M., & Wessie, F. (2012). Knowledge and practices of farmers with reference to pesticide management: Implications on human health. *Archives of environmental and occupational health*, 109 - 116.

Kayumba, A. (2008). *Work environment and respiratory health among sisal processors in Tanzania.* Norway: University of Bergen.

Kayumba, A., Bratveit, M., & Y Mashalla, B. M. (2007). Acute respiratory symptoms among sisal workers in Tanzania. *http://occmed.oxfordjournals.org* 290 - 293.

Kim, J., Arrandale, H., Kudia, I., Mardell, K., & Holness, D. L. (2012). Education intervention among farmers in a community health care setting. *Occupational medicine*, 458 - 461.

KNBS. (2013). *Irrigation schemes.* Retrieved from Kenya National Bureau of Statistics: www.knbs.or.ke accessed on 10/1/2015

KNBS. (2016). *Economic survey, 2016.* Nairobi: Kenya National beureau of statictics.

Kuria, J., Ommeh, H., Kabuage, L., Mbogo, S., & Mutero, C. (2003). Technical efficiency of rice producers in Mwea Irrigation Scheme. *Africa crop science conference proceedings* (pp. 668 - 673). Uganda: Africa crop science society.

Kuye, R., Donham, K., & Marquez, S. (2006). Agricultural health in Gambia 11: A systematic survey of safety and injuries in production agriculture. *Annals of agricultural and environmental medicine* , 119 - 128.

Langley, R. L., & Morrow, W. E. (2010) 'Livestock Handling—Minimizing Worker Injuries', *Journal of Agromedicine*, *15*(3), 226-235

Lee, K., & Lim, H. (2008). Work related injuries and diseases of farmers in Korea. *Industrial Health*, 424 - 434.

Lee, K., & Lim, H.-S. (2008). Work related injuries and diseases of farmers in Korea. *Industrial health* , 424 - 434.

Leigh, J., McCurdy, S., & Schenker, M. (2001). *Costs of occupational injuries in Agriculture.* Public Health reports May - June 2001.

Litchfield, M. (1999). Agricultural work related injury and ill-health and the economic cost. *Journal of environmental health & pollution research Vol 6*, 175 - 182.

Mburu, C. (2006). *An evaluation of health and safety measures taken by tobacco farmers of Eastern Kenya while handling agricultural chemicals.* Leicester: MSc desertation, University of Leicester, UK.

Mugenda, O., & Mugenda, A. (2003). *Research methods: Quantitative and Qualitative approaches.* Nairobi: Nairobi Acts Press.

Muileman, S. (2013). *Occupational safety and health on Ghana cocoa farms. Baseline report.* International institute of tropical agriculture, Ghana. www.iita.org.

National Irrigation Board. (2014). *Mwea irrigation scheme.* Nairobi: http://www.nib.or.ke

National Pesticide Telecommunications Network. (1998). *Cypermethrin.* Oregon: Oregon State university.

NCBI. (n.d.). *U S National Library of medicine*. Retrieved from National Centre for Biotechnology Information: https://pubchem.ncbi.nlm.nih.gov/ compound/ cymoxanil#section=Top

NPIC. (2001). *Lambda - cyhalothrin General fact sheet.* Retrieved from National Pesticide Information Center: http://www.nipc.orst.edu/factsheets/...

NPIC. (2001). *Lambda-cyhalothrin General fact sheet.* Retrieved from National Pesticide Information Center: http://www.nipc.orst.edu

Nyabonyi, J. O. (2016). *Suitability assessment of effluents from Mwea irrigation scheme for re-use in irrigation for rice production, Kirinyaga County, Kenya.* Retrieved from Kenyatta University Institutional Repository: http://www.ir-library.ku.ac.ke

Okereke, D. I., & Okereke, S. N. (2015). Occupational diseases and illness affecting rice farmers in Afikpo North Local government area of Ebonyi state. *Science Journal of Business and Management*, 65 - 68.

Olowogbon, S. (2011). Health and safety in agriculture and food security nexus. *International journal of emerging sciences*, 73 - 82.

OSHA. (2014, August). *Protecting workers from the effect of heat.* Retrieved from OSHA Fact Sheet: http://www.osha.gov/OshDoc/data_Hurricane_Facts/ heat.stress.pdf

OSHA. (nd). *Protecting Workers from the Effect of Heat.* Retrieved from OSHAFactsheet: http://www.osha.gov/OshDoc/data_Hurricane_ Facts/heat_ stress.pdf

OSHA (2018). Ocupational safety and health administration: Farm safety. Retrieved from https://www.osha.gov

Pascuzzi, S., & Santoro, F. (2017, 05). Evaluation of farmers OSH hazard in operation nearby mobile telephone radio base station. *Enineering for Rural Development*. Italy: University of Bari Aldo Moro. Retrieved from http://tf.llu.lv/conference/proceedings2017/Papers/N151.pdf

PCPB. (2018). *Registered products in Kenya for use on crops*. Retrieved from Pest Control Products Board: http://pcpb.or.ke/cropproductsviewform.php

Pest Control Products (Kenya) Act, Cap 346. (1982). Retrieved from http://extwprlegs1.fao.org/docs/pdf/ken63608.pdf

Pinzke, S., Svennefelt, C. A., & Lundqvist, P. (2018). Occupational injuries in Swedish agriculture - development and preventative actions. *Journal of Agricultural Safety and Health (in press). (doi: 10.13031/jash.12816).*

Pullock, K. (2010). *The economic cost of farm related fatalities and the perceptions and management of health and safety on Australian farms.* Sydney Medical School, PhD Thesis, University of Sydney.

Ricky L. Langley, W. E. (2010). Livestock Handling - Minimizing Worker Injuries. *Journal of Agromedicine*, 226 - 235.

Safe Work Australia. (2018). *Cost of injuries and illness.* Retrieved from https://www.safeworkaustralia.gov.au/

Short, C., Mulinge, W., & Witwer, M. (2012). *Analysis of incentives and disincentives for rice in Kenya. Technical notes series.* Rome: MAFAP, FAO.

Takala, J. e. (2014). Global Estimates of the Burden of Injury and Illness at Work in 2012. *Journal of Occupational and Environmental Hygiene*, 326 - 337.

Takala, J., Hamalainen, P., Saarela, K. L., Yun, L. Y., Manickam, K., Jin, T. W., . . . Lin, G. S. (2014). Global Estimates of the Burden of Injury and illness at Work 2012. *Journal of Occupational and Environmental Hygiene*, 326 - 337.

Veerappan, M., Hwang, I., & Pandurangan, M. (2012). Effect of Cypermethrin, carbendazim and their combination on male albino rat serum. *International Journal of Experimental Pathology*, 361 - 369.

Von Essen SG, M. S. (1997). Health and safety in production agriculture. *West J Med*, (pp. 214 - 220). California.

Water Sector Trust Fund. (n.d.). *Irrigation status*. Retrieved from Water Sector Trust Fund: www.waterfund.go.ke

White, G., & Cessna, A. (1989). Occupational hazards of farming. *Canadian Family Physician journal*, *35*,:2331 - 2336.

Yonelia, A., & Kurniawidjaja, l. (2013). Risk management of occupational health and safety in rice farmers in Ngrendeng, East Java in 2012. *International journal on advanced science engineering information technology* *3*(1).

Zukiewicz-Sobczak, W. A., Chmielewska-Badora, J., Wroblewska, P., & Zwolinski, J. (Oct 2013). Farmer's occupational diseases of allergenic and zoonotic origin. *Postepy Dermatol Alergol 30*(5), 311 - 315.

APPENDICES

Appendix I: Informed Consent

Hello,

My name is Charles Muiruri Mburu, a student of Jomo Kenyatta University of Agriculture and Technology, Kenya. I am conducting a safety and health research on farm workers at the Public irrigation schemes in Kenya in partial fulfilment of a Doctorate degree from JKUAT and would appreciate your participation. I would therefore like to ask you some questions regarding safety and health in your work. The information you will give is for academic purposes and you will not be required to give your name. The information will help us and the regulator to understand better the safety and health issues that affect farmers in Kenya and thereby assist in the development of mitigation measures.

Whatever information you provide will be treated in confidence and will not be shared with other participants. Participation is voluntary and you can choose not to answer some or all questions. You can also withdraw from the interview at any point in the interview process with no consequences. However, I hope you will agree to participate since your contribution is very important.

At this time you may ask me any question

(After answering the question or if there is no question)

May I begin the interview now?

RESPONDENT AGREES TO BE INTERVIEWED.....

Administer the questionnaire

RESPONDENT DOES NOT AGREE TO BE INTERVIEWED..... End of interview

Date.....

Appendix II: Farm Worker Individual Interview – Questionnaire

Questionnaire No..... Irrigation scheme.....

A. Profile of the farm worker

01	Enter the gender of the respondent	Male..... Female.....	

I would like to ask some personal information

02	What is your age? (If not known give approximate age)	Below 20..... 21 – 35..... 36 – 45..... 46 – 60..... Above 60.....
03	What is the highest level of education you attended?	None..... Primary..... Secondary..... Tertiary college..... University..... Others.....
04	How long have you been engaged in farm work?	Below 5 years.....

		5 – 10.....
		11 – 19.....
		20 – 30.....
		Above 30years.....
05	Do you work in your farm or are you employed?	Own.....
		Employee.....
06	Do you employ farm workers	Yes.....
		No.....
07	What is the size of the farm?	Below 1 acre.....
		1 – 4 acres.....
		Above 4 acres.....
08	List the crops that you grow	1.....
		2.....
		3.....
		4.....
		5.....
09	Do you keep livestock in your farm?	Yes.....
		No.....
10	How much do you earn from the current work in a year on average?	Below Ksh 60,000...
		61,000 – 120,000.....
		121,000 – 360,000

361,000 – 600,000...

Above 600,000....

B Occupational hazards at the workplace (to be supplemented by a checklist)

11	Do you spray agrochemicals in your farm?	Yes..... No.....
	Give name(s) of the chemicals Pesticides..... Herbicides..... Fungicides.....	
12	Do you use any form of machine?	Yes.....
	Give machine type	No.....
13	Do you use a handcart in your farm?	Yes..... No.....
14	Is the handcart animal driven?	Yes.....
	Which animal?.....	No.....
15	Do you use hand tools for your farming?	Yes..... No.....

Please list them

.....

16 Do you lift heavy objects in the course of your work? Yes.....

No.....

List the objects

.....

Approximate weight.....Kgs

17 Does you work involve working in a dusty environment? Yes.....

No.....

List types of dust

Soil dust.....

Pollen dust.....

Others.....

18 Does your work involve working in wet environment? Yes.....

No.....

19 Does your work involve working in hot weather? Yes.....

No.....

20 Does your work involve working at height? Yes.....

No.....

21 Are you likely to be bitten by animals/insects in the course of work? Yes.....

No.....

List the animals and insects

.....

.....

.....

C Work related injuries and ill-health

22	Have you or a member of your family been taken ill after spraying chemicals?	Yes..... No..... Can't remember.....
23	If yes, how were you treated?	Bought pain killers..... Outpatient in hospital..... Admitted in hospital.....
24	How long were you indisposed?	A few hours..... 1 day..... More than 3 days..... Hospital/Home.....
25	What were the symptoms?	Headache..... Dizziness..... Sneezing.....

		Vomiting.....
		Loss of sleep.....
		Breathing problems.....
		Rashes on skin.....
		Others.....
26	Have you ever been injured while working?	Yes.....
		No.....
27	What caused the injury?	Machine.....
		Cart.....
		Tools.....
		Lifting load.....
		Fall from height.....
		Others.....
28	Which part of the body was injured?	Hand.....
		Leg.....
		Back.....
		Head.....
		Other.....
29	How long were you indisposed?	1 day.....
		1 – 2 days.....

		3 days and above.....
30	How did you get treated?	In hospital.....
		At home.....
		Admitted in hospital.....
31	Have you ever been bitten by a snake?	Yes.....
		No.....
32	If yes how did you get treated?	In hospital.....
		At home.....
33	Have you ever suffered from Malaria attack?	Yes.....
		No.....
34	If yes, how long were you indisposed?	1 day.....
		1 – 2 days.....
		3 days and above.....
35	How did you get treated?	In hospital.....
		At home.....
		Admitted in hospital.....
36	Have you ever suffered from Bilharzia?	Yes.....
		No.....
37	If yes, how long were you indisposed?	1 day.....
		1 – 2 days.....
		3 days and above.....

38	Do you feel pain in the body that may be related to the work that you do?	Yes..... No.....
39	If yes which part of the body aches?	Arm..... Hand..... Shoulder..... Back..... Neck..... Lower back..... Legs..... Others.....
40	Within the last 12 months have you been admitted in hospital?	Yes..... No.....
41	What was the nature of ailment?	Malaria..... Bilharzia..... Typhoid..... Back pains..... Aching bones..... Flu..... Others.....
42	How long were you indisposed	Number of days.....

43	Name of hospital or health centre	.....
44	Type of hospital/health centre	Government..... Private.....
45	Distance of hospital/health centre from your home	..... km
46		

Within the last 12 months, have you been sick or injured but not admitted in hospital?

If yes state nature of the ailments and period indisposed

Yes.....

No.....

.... days

D Constraints hindering good OSH practices

Tick the most appropriate answer to the following questions;-

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

1	There is a law in Kenya to protect workers from work related injuries and ill-health	A	B	C	D	E
2	Farmers who do not use personal protection equipment while handling chemicals stand a high chance of dying					
3	It is important to read chemical labels before handling them					
4	Work in an environment of stagnant water is likely to cause diseases					
5	Lifting heavy loads is likely to cause ill-health					
6	Personal protective equipment are available in the shops					
7	Personal protective equipment are affordable					
8	I have been trained on safe work practices					
9	I have been trained on the need to wear protective equipment					
10	The agricultural officers conduct training on safe use of chemicals					
11	Farmers are advised on the types of chemicals to be used					
12	Maintenance of carts and other machinery reduces the risk of accidents					

Many thanks for your participation and cooperation. Your contribution will go a long way to add knowledge on the occupational injuries and ill-health that farmers encounter in the course of their work at the scheme.

Appendix III: Questionnaire to Hospitals/Health Centres

1. Name of the hospital / health centre.....
2. Person in charge of the hospital or health center…….
3. Number of doctors……Occupational doctors…….
4. Number of clinical officers……Occupational Clinical Officers……
5. Number of nurses……Occupational nurses……..
6. Average number of patients seen in a day.....

ENDEMIC AILMENTS AND INJURIES

Tabulate 10 endemic ailments and injuries that are reported in this hospital/health centre

	DISEASE NAME	APPROX No. OF PATIENTS PER DAY	APPROX COST PER PERSON
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

7. Does the facility receive and treat cases of occupational diseases and injuries?

   Yes / No.....

   What are the main injuries and symptoms of the occupational diseases that are presented in this facility?

   1. .....
   2. .....
   3. .....

Are there reported cases of leishmaniasis, fascioliasis, bilharziasis, mycosis, tetanus, and malaria?
.....

Many thanks for your participation and cooperation. Your contribution will go a long way to add knowledge on the occupational injuries and ill-health that farmers encounter in the course of their work at the scheme.

Appendix IV: Questionnaire to Agricultural Officer

1. Name of County.....
2. Name of sub-county.....
3. Position of officer.....
4. Area represented.....
5. Cash crops grown in the area
    a. ……
    b. …….
    c. ……
6. Subsistence crops grown in the area
    a. …….
    b. …….
    c. ……..
7. Does the department organize for farmer's training on occupational hazards? Yes/No…….
8. Does the department organize for farmer's training on safe handling of chemicals? Yes/No……
    a. If yes when was the last training? .....
    b. What training methods are used? .....
    c. If no, who is responsible for the organization? .....
    d. Does your department advice farmers on the approved chemicals by PCPB?
    e. Is your department satisfied with the use of personal protection by farmers against occupational safety and health hazards? Yes / No……
    f. In your own opinion, why do farmers not apply good OSH practice in their work?
        i. ……..
        ii. ……
        iii. ……..

Many thanks for your participation and cooperation. Your contribution will go a long way to add knowledge on the occupational injuries and ill-health that farmers encounter in the course of their work at the irrigation scheme.

Appendix V: Hazard Recording Checklist

ACTIVITY	HAZARDS IDENTIFIED	REMARKS
LAND PREPARATION	1.	
	2.	
	3.	
	4.	
	5.	
PLANTING	1.	
	2.	
	3.	
	4.	
	5.	
WEEDING	1.	
	2.	
	3.	
	4.	
	5.	
CROP HUSBANDRY	1.	
	2.	
	3.	
	4.	
	5.	
HARVESTING	1.	
	2.	
	3.	
	4.	
	5.	

02	What is your age? (If not known give approximate age)	Below 20..... 21 – 35..... 36 – 45..... 46 – 60..... Above 60.....	
03	What is the highest level of education you attended?	None..... Primary..... Secondary..... Tertiary college..... University.....	
04	How long have you been engaged in farm work?	Below 5 years..... 5 – 10..... 11 – 19..... 20 – 30..... Above 30years.....	
05	What is the size of the farm?	Below 1 acre..... 1 – 4 acres..... Above 4 acres.....	

06	Do you keep livestock in your farm?	Yes..... No.....	
07	How much do you earn from the farm in a year on average?	Below Ksh 60,000... 61,000 – 120,000..... 121,000 – 360,000 361,000 – 600,000... Above 600,000....	

Appendix VI: Post intervention questionnaire

Questionnaire No..... MWEA Irrigation scheme

A. Profile of the farm worker

01 Enter the gender of the respondent Male.....

Female.....

I would like to ask some personal information

B OSH Knowledge and practices

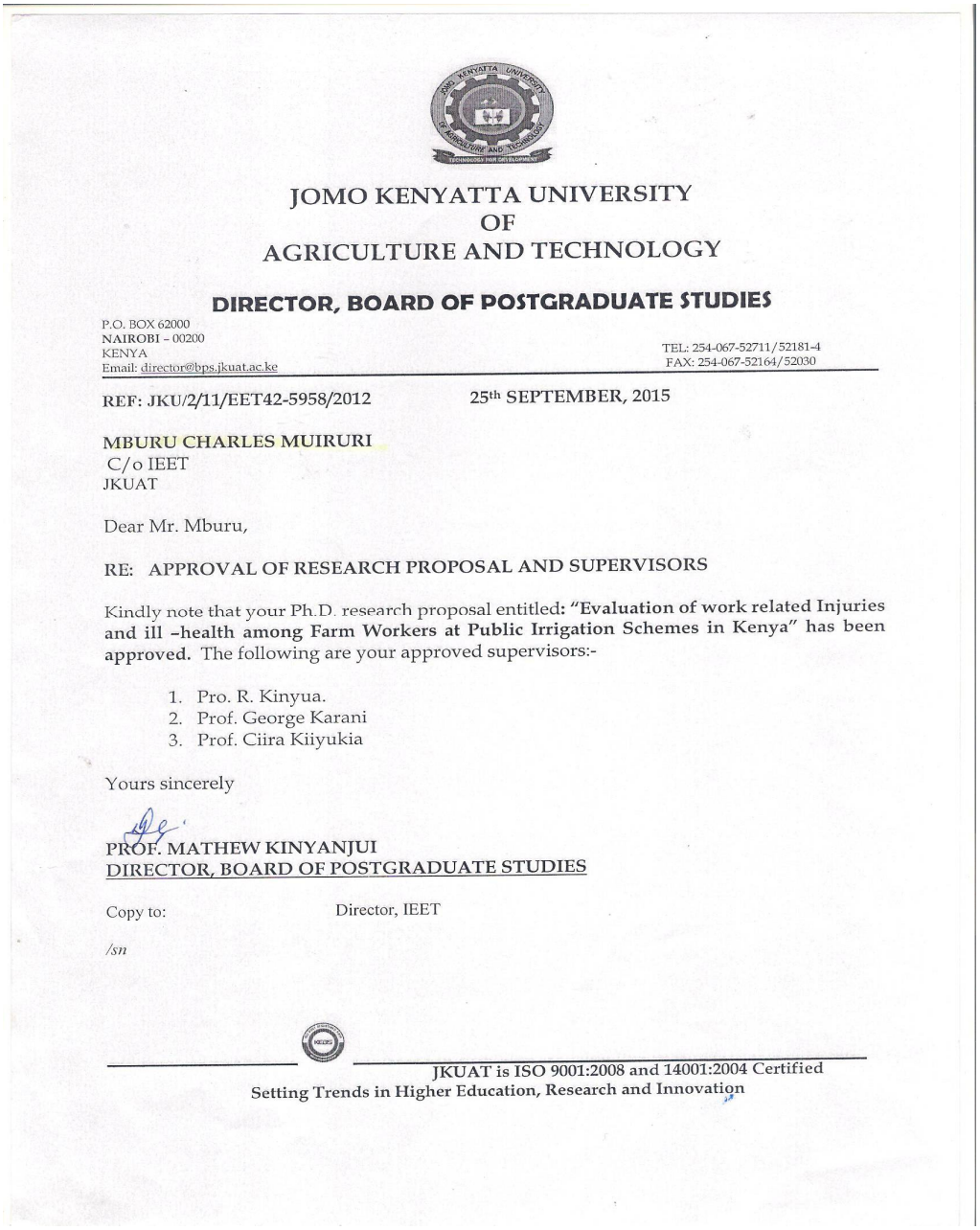
Tick the most appropriate answer to the following questions;-

		Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1	There is a law in Kenya that protects workers from work related injuries and ill-health	1	2	3	4	5
2	It is important to read chemical labels before handling them					
3	Farmers who do not use personal protection equipment while handling chemicals stand a high chance of dying					
4	Personal protective equipment are available in the shops					
5	Personal protective equipment are affordable					

6	I have been trained on the need to wear protective clothing and equipment					
7	Work in an environment of stagnant water is likely to cause ill health					
8	Drinking irrigation canal water can causes illness eg typhoid					
9	It is good to boil drinking water always					
10	Lifting heavy loads is likely to cause ill-health					
11	I have been trained on safe work practices					
12	Tools and machinery are a source of injuries to farm workers					
13	Livestock are a source of injuries to the farm workers					
14	Livestock spreads diseases to the farm workers					

Many thanks for your participation and cooperation. Your contribution will go a long way to add knowledge on the occupational injuries and ill-health that farm workers encounter in the course of their work at the scheme.

Appendix VII: JKUAT Research approval



JOMO KENYATTA UNIVERSITY
OF
AGRICULTURE AND TECHNOLOGY

DIRECTOR, BOARD OF POSTGRADUATE STUDIES

P.O. BOX 62000
NAIROBI – 00200
KENYA
Email: director@bps.jkuat.ac.ke
TEL: 254-067-52711/52181-4
FAX: 254-067-52164/52030

REF: JKU/2/11/EET42-5958/2012 25th SEPTEMBER, 2015

MBURU CHARLES MUIRURI
C/o IEET
JKUAT

Dear Mr. Mburu,

RE: APPROVAL OF RESEARCH PROPOSAL AND SUPERVISORS

Kindly note that your Ph.D. research proposal entitled: **"Evaluation of work related Injuries and ill –health among Farm Workers at Public Irrigation Schemes in Kenya" has been approved.** The following are your approved supervisors:-

1. Pro. R. Kinyua.
2. Prof. George Karani
3. Prof. Ciira Kiiyukia

Yours sincerely

PROF. MATHEW KINYANJUI
DIRECTOR, BOARD OF POSTGRADUATE STUDIES

Copy to: Director, IEET

/sn

Appendix VIII: JKUAT/IEET Introduction letter

JOMO KENYATTA UNIVERSITY
OF
AGRICULTURE AND TECHNOLOGY

INSTITUTE OF ENERGY AND ENVIRONMENTAL TECHNOLOGY

P.O. BOX 62000, Nairobi, Kenya. Tel: (067) 52251/52711/52181-4, Fax: (067) 52164 Thika, Email: director@ieet.jkuat.ac.ke

TO WHOM IT MAY CONCERN **DATE: 15TH OCTOBER, 2015**

SUBJECT: EET42-5958/2015- MBURU CHARLES MUIRURI

The above named person is a postgraduate student at the Institute of Energy and Environmental Technology (IEET) in Jomo Kenyatta University of Agriculture and Technology. He is pursuing the Doctor of Philosophy degree in Occupational Safety and Health and he is currently undertaking his research on ***"Evaluation of work related injuries and ill health among farm workers at public irrigation schemes in Kenya".***

Any assistance given to him will be highly appreciated and the information given thereof shall be treated professionally and shall only be used for the purpose of producing the thesis. The student has undertaken to follow the research ethics as stipulated by the university.

Thank you for your assistance.

PROF. R. KINYUA
DIRECTOR, INSTITUTE OF ENERGY AND ENVIRONMENTAL TECHNOLOGY

Appendix IX: Ethical approval by Ethics Review Committee

KENYATTA UNIVERSITY
ETHICS REVIEW COMMITTEE

Email: chairman.kuerc@ku.ac.ke
secretary.kuerc@ku.ac.ke
ercku2008@gmail.com
Website: www.ku.ac.ke

P. O. Box 43844 - 00100 Nairobi
Tel: 8710901/12
Fax: 8711242/8711575

Our Ref: KU/R/COMM/51/658 Date: 15th March, 2016

Charles Muiruri Mburu
Jomo Kenyatta University,
P.O Box 62000-00100,
Nairobi

Dear Mburu,

APPLICATION NUMBER PKU/454/E40– "EVALUATION OF WORK RELATED INJURIES AND ILL HEALTH –HEALTH AMONG FARM WORKERS PUBLIC IRRIGATION SCHEMES IN KENYA"- VERSION 2

1. IDENTIFICATION OF PROTOCOL
The application before the committee is with a research topic, **"Evaluation of work related injuries and ill health –health among farm workers public irrigation schemes in Kenya"** – Version 2 received on 9th March, 2016.

2. APPLICANT
Charles Muiruri Mburu

3. SITE
Mwea, Perkerra and Ahero irrigation Schemes, Kenya

4. DECISION
The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines **AND APPROVED that the research may proceed for a period of ONE year from 15th March, 2016.**

5. ADVICE/CONDITIONS
i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study.
ii. Serious and unexpected adverse events related to the conduct of the study are reported to this board immediately they occur.
iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.
iv. Submit an electronic copy of the protocol to KUERC.

When replying, kindly quote the application number above.
If you accept the decision reached and advice and conditions given please sign in the space provided below and return to KU-ERC a copy of the letter.

KENYATTA UNIVERSITY ETHICS REVIEW COMMITTEE P.O. BOX 43844 - 00100 NAIROBI
16 MAR 2016

DR. TITUS KAHIGA
CHAIRMAN ETHICS REVIEW COMMITTEE

I Charles M. Mburu .....accept the advice given and will fulfill the conditions therein.

Signature..... Dated this day of....16th March..... 2016.

cc. Vice-Chancellor
DVC-Research Innovation and Outreach

Appendix X: Incidence of disease in Kenya 2013 – 2017

DISEASE	2013		2014		2015		2016		2017*	
	Number	%	Number	%	Number	%	Number	%	Number	%
Malaria.....	8,808,471	20.2	9,660,992	20.5	7,663,625	16.7	8,325,387	16.4	7,958,213	18.7
Disease of the Respiratory System ...	14,823,864	34.0	17,998,237	38.3	18,264,778	39.8	19,621,737	38.7	14,482,269	34.0
Diseases of the Skin (Incl. Ulcers).....	3,648,361	8.4	4,556,925	9.7	4,755,915	10.4	4,409,229	8.7	3,261,935	7.7
Diarrhoea Diseases.....	2,226,107	5.1	3,013,256	6.4	3,115,168	6.8	2,892,638	5.7	2,601,827	6.1
Intestinal Worms.....	349,632	0.8	357,319	0.8	326,297	0.7	763,793	1.5	763,463	1.8
Pneumonia.....	1,282,996	2.9	1,509,851	3.2	1,508,212	3.3	1,616,913	3.2	1,208,592	2.8
Accidents (ind. fractures, burns etc)	927,861	2.1	1,079,933	2.3	1,154,067	2.5	1,311,911	2.6	1,135,456	2.7
Rheumatism, Joint pains etc.....	1,081,245	2.5	1,352,330	2.9	1,474,433	3.2	1,572,172	3.1	1,246,731	2.9
Urinary Tract Infections.....	1,091,371	2.5	1,361,275	2.9	1,541,276	3.4	1,697,479	3.3	1,555,733	3.7
Eye Infection.....	778,073	1.8	1,002,778	2.1	988,183	2.2	1,004,923	2.0	655,815	1.5
All Other Diseases	8,618,536	19.8	5,145,714	10.9	5,112,489	11.1	7,537,918	14.9	7,466,490	17.5
TOTAL.....	43,636,517	100	47,038,650	100.0	45,904,443	100	50,754,100	100	42,336,524	100

Source: Ministry of Health, Health Management Information System

*Provisional

Source: Economic survey 2018, Kenya

Appendix XI: Inferential statistics

AHERO SCHEME -**Lift Heavy objects * Body Pains Cross-tabulation**

			Body Pains		Total
			BODY PAINS	NONE RESPONSE	
Lift Heavy objects	YES	Freq.	5	17	22
		% of Total	15.6%	53.1%	68.8%
	NO	Freq.	6	4	10
		% of Total	18.8%	12.5%	31.2%
Total		Freq.	11	21	32
		% of Total	34.4%	65.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.234[a]	1	.040		
Continuity Correction[b]	2.743	1	.098		
Likelihood Ratio	4.141	1	.042		
Fisher's Exact Test				.056	.050
Linear-by-Linear Association	4.102	1	.043		
N of Valid Cases	32				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 3.44.

b. Computed only for a 2x2 table

AHERO SCHEME -Spray agrochemicals * Admitted last 12 months in hospital Cross-tabulation

			Admitted in hospital last 12 months		Total
			YES	NO	
Spray agrochemicals	Yes	Freq.	26	11	37
		% of Total	68.4%	28.9%	97.4%
	No	Freq.	0	1	1
		% of Total	0.0%	2.6%	2.6%
Total		Freq.	26	12	38
		% of Total	68.4%	31.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.225[a]	1	.136		
Continuity Correction[b]	.161	1	.688		
Likelihood Ratio	2.365	1	.124		
Fisher's Exact Test				.316	.316
Linear-by-Linear Association	2.167	1	.141		
N of Valid Cases	38				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .32.

b. Computed only for a 2x2 table

MWEA SCHEME – Spray Agro chemicals * Admitted in hospital last 12 months Cross-tabulation

			Admitted in hospital last 12 months		Total
			YES	NO	
Spray Agro chemicals	Yes	Freq.	80	157	237
		% of Total	27.6%	54.1%	81.7%
	No	Freq.	13	40	53
		% of Total	4.5%	13.8%	18.3%
Total		Freq.	93	197	290
		% of Total	32.1%	67.9%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.693[a]	1	.193		
Continuity Correction[b]	1.296	1	.255		
Likelihood Ratio	1.758	1	.185		
Fisher's Exact Test				.254	.127
Linear-by-Linear Association	1.687	1	.194		
N of Valid Cases	290				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 17.00.

b. Computed only for a 2x2 table

PERKERRA SCHEME – Spray Agro chemicals * Last 12 months admitted Cross-tabulation

			Admitted in hospital last 12 months		Total
			YES	NO	
Spray Agro chemicals	Yes	Freq.	10	35	45
		% of Total	20.4%	71.4%	91.8%
	No	Freq.	2	2	4
		% of Total	4.1%	4.1%	8.2%
Total		Freq.	12	37	49
		% of Total	24.5%	75.5%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.533[a]	1	.216		
Continuity Correction[b]	.399	1	.528		
Likelihood Ratio	1.334	1	.248		
Fisher's Exact Test				.248	.248
Linear-by-Linear Association	1.502	1	.220		
N of Valid Cases	49				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .98.

b. Computed only for a 2x2 table

AHERO -Education * Pesticides Cross-tabulation

			Pesticides						
			TATA UMEME	COLT	ROBUST	TITAN	DUDUT HRIN	CANT REMEMBER	DONT KNOW
EDUCATION	None	Freq.	2	1	0	0	0	0	1
		%	5.4%	2.7%	0.0%	0.0%	0.0%	0.0%	2.7%
	Pry	Freq.	4	6	1	1	0	1	1
		%	10.8%	16.2%	2.7%	2.7%	0.0%	2.7%	2.7%
	Sec	Freq.	5	4	2	2	1	0	0
		%	13.5%	10.8%	5.4%	5.4%	2.7%	0.0%	0.0%
	college	Freq	3	1	0	1	0	0	0
		%	8.1%	2.7%	0.0%	2.7%	0.0%	0.0%	0.0%
Total		Freq.	14	12	3	4	1	1	2

%	37.8%	32.4%	8.1%	10.8%	2.7%	2.7%	5.4%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.770[a]	18	.859
Likelihood Ratio	12.936	18	.795
Linear-by-Linear Association	.946	1	.331
N of Valid Cases	37		

a. 26 cells (92.9%) have expected count less than 5. The minimum expected count is .11.

Appendix XII: Publications

1. Mburu, C., Kinyua, R., Karani, G., & Kiiyukia, C. (2018). Occupational Safety and Health Hazards Exposure among Farm Workers at Ahero irrigation scheme, Kenya. *EPH - International Journal of Agriculture and Environmental Research* 4 (9), 01 – 13
2. Mburu, C., Kinyua, R., Karani, G., & Kiiyukia, C. (2018). Work Related Ill Heath among Farm Workers at Ahero Irrigation Scheme, Kenya. *International Journal of Science and Research* Vol 7 issue (280 – 284).
3. Mburu, C., Kinyua, R., Karani, G., & Kiiyukia, C. (2018). Work related injuries and ill health among farm workers at Mwea irrigation scheme, Kirinyaga County, Kenya. *Journal of Agricultural Safety and Health*. Under review.