DETERMINANTS OF MALARIA IN IRRIGATED AND NON-IRRIGATED VILLAGES OF MWEA: A COMPARATIVE ASSESSMENT

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE MASTER OF PUBLIC HEALTH DEGREE OF THE UNIVERSITY OF NAIROBI

Declaration

I declare that this thesis is my original work. It has not been published or submitted elsewhere for examination.

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Dedication

This thesis is dedicated to:

- ❖ God, for His ever-present love;
- ❖ My wife Maggie and our children for their support;
- ❖ My parents for their blessings.

Thank you all.

Acknowledgment

This study was largely funded by the International Development Research Centre (IDRC) Canada [Centre File 1004821] through the International Centre of Insect Physiology and Ecology (ICIPE) and the International Water Management Institute (IWMI).

I would in addition like to acknowledge the following:

- My supervisors Prof. V. Kimani, Dr. Y. Kombe, Mr. L. Nyabola, and Dr. G. K. Gitau for their guidance, valuable advice, and encouragement;
- Dr. Clifford Mutero [Coordinator, CGIAR Systemwide Initiative on Malaria and Agriculture (SIMA); International Water Management Institute (IWMI), Pretoria, South Africa] for his valuable advice, guidance, and leadership and for availing the funds for this study through ICIPE;
- Ms. Charity Kabutha, a gender and participatory development specialist and social scientist for facilitating training of the research team in participatory methodologies;
- Dr. Lucy Kabuage, who was part of the core research team, for her valuable support and leadership;
- Alice S. Lakati of the Department of Environmental Health, Kenya Medical Training College (Nairobi), for data analysis and valuable input on interpretation and presentation of findings;
- Dr. John Githure of ICIPE for his part in facilitating the provision of field equipment and consumables;
- Mr. Enock Mpanga of ICIPE for co-ordinating the fieldwork and participating in it;
- Mr. Joseph Muchiri, Mr. Mbai, and Mr. Muriuki of ICIPE for their safe driving during the field work;

- The ICIPE field assistants Mr. P. Ng'ang'a and Mr. W. Baraza for their help in interviewing the subjects and for their logistic support;
- Dr. Beth Rapuoda of the DOMC, Ministry of Health (Kenya) for her provision of valuable literature and support in approval of the study;
- Dr. K. Njagi of KEMRI for his valuable input and assistance in securing laboratory usage and personnel;
- Mr Mwangi Muthee and Ms. Marion Njeri of the DVBD Laboratory in Kimbimbi for their help in preparation of blood films and examination of the same;
- Dr. Ochola, Head of the DOMC, Ministry of Health (Kenya) for approving the study;
- Dr. J. Omumbo of the Wellcome Trust Foundation for her provision of literature and friendly advice;
- Mr. Ben Muchoki of the Department of Community Health, College of Health Sciences, University of Nairobi for coding, cleaning, and inputting the data;
- Miss. Jane Gatune of the Department of Community Health, College of Health Sciences, University of Nairobi for help in collection, coding, and cleaning of data and for valuable advice;
- Dr. Lucy Musyoka for her friendly advice, valuable input and help in data collection and the preliminary preparation for the PRA;
- Mr. Kiarie Gituanjah for his help in data collection;
- The field assistants for interviewing the subjects;
- The National Irrigation Board for valuable information and assistance;
- Communities in Mwea for their co-operation;
- The various stakeholders in Mwea for their valuable input.

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Definition of Terms and Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
Artemisinin	An extract of the plant *Artemisia annua* used notably by the Chinese for treatment of malaria and possibly other febrile illnesses
Artesunate	Artemisinin-derived anti-malarial drug (see Artemisinin above)
Biomass	The weight of living tissues, usually measured per unit area over a particular time interval and can include the dead parts of organisms
BMI	Body Mass Index
CGIAR	Consultative Group on International Agricultural Research
Cytoadherence	Specific adherence of *Plasmodium falciparum*-infected erythrocytes (IRBCs) to venular endothelium, thereby evading spleen-dependent immune mechanisms
DDT	Dichlorodiphenyltrichloroethane - a pesticide once widely used to control insects in agriculture and insects that carry diseases such as malaria
DOMC	Division of Malaria Control (of the Ministry of Health - Kenya), which until October 2000 was known as the National Malaria Control Programme (NMCP)
DVBD	Division of Vector Borne Diseases
FGDs	Focus Group Discussions
High Parasite Biomass	Large numbers of individual parasites
HIV	Human Immunodeficiency Virus
ICIPE	International Centre of Insect Physiology and Ecology
IDRC	International Development Research Centre
Intrapartum	During labour

Irrigated/Non-Irrigated Villages	Villages within the Irrigated (Mwea Irrigation Scheme)/Non-Irrigated Areas
IRS	Indoor Residual House Spraying
ITN	Insecticide-Treated Mosquito/Bed Net(s)
IWMI	International Water Management Institute
KEMRI	Kenya Medical Research Institute
km	Kilometre(s)
Malaria Prevalence Survey	The collective exercise during which a malaria parasite prevalence was carried out in each village
Mwea	Mwea Division, Kirinyaga District, Central Province, Republic of Kenya
NIB	National Irrigation Board
PHT	Public Health Technician
PRA	Participatory Rural Appraisal
Primigravidae	First Pregnancy
PSC	Pyrethrum Spray Catch
RBM	Roll Back Malaria
Secundigravidae	Second Pregnancy
SP	Sulpha-Pyrimethamine
SPSS	Statistical Product and Service Solutions (initially Statistical Package for the Social Sciences)
UNDP	United Nations Development Fund
UNICEF	United Nations Children's Fund
WHO	World Health Organisation

Abstract

Today, approximately 40% of the world's population, mostly those living in the poorest countries, are at risk of malaria,[1,2] which causes more than 300 million acute illnesses and at least one million deaths annually. Ninety per cent of deaths due to malaria occur in sub-Saharan Africa, mostly among young children. The importance of malaria cannot be over-emphasized. A project, (Agro-ecosystem Management for Community-Based Integrated Malaria Control in East African Irrigation Schemes) is currently underway in Mwea Division, Kirinyaga District, Kenya, under the auspices of the International Development Research Centre (IDRC) Canada and the International Centre of Insect Physiology and Ecology (ICIPE) in conjunction with the International Water Management Institute (IWMI). The overall aim of this ICIPE-IWMI Project is to improve the health and well-being of communities in irrigation schemes through the development of sustainable strategies for reduction of malaria and other health risks based on improved agro-ecosystem management. In Kenya, a considerable part of the area under irrigation is for rice production. The choice of Mwea is appropriate since it provides an ideal setting in which human health can be factored into agro-ecosystem research, thereby meeting the objectives of the ICIPE-IWMI Project.

This cross-sectional descriptive study was part of the larger ICIPE-IWMI Project. Its main objective was to compare malaria prevalence and to assess the potential environmental and socio-economic determinants of the disease in irrigated (Ciagi-ini and Mbui Njeru) and non-irrigated (Kagio and Murinduko) villages of Mwea. Quantitative data was obtained from one cycle of malaria prevalence surveys, undertaken in two villages within the irrigated area that were matched with two control villages in the non-irrigated area beyond the flight range of mosquitoes. This collective Malaria Prevalence Survey was carried out on 213 children

aged 9 years and under, in December 2001 and February 2002. The response rate was 74.5%. Qualitative data was obtained through participatory methodologies carried out within the four villages and involved selected stakeholders and other target groups from Mwea. In addition, a Community Diagnosis was carried out in 420 households within the four villages.

Malaria was ranked as the major health problem in all the four study villages (except at the Stakeholders' Consultative Workshop where it was ranked second). Within the irrigated villages, malaria, alcoholism, and lack of clean water were the predominant problems. Within the non-irrigated villages, the predominant problems were poor nutrition, HIV/AIDS, lack of sewerage systems, poverty, and ignorance. Poverty was not perceived as a problem at all within the irrigated villages but was a problem in Murinduko village in the non-irrigated area. Kagio, also in the non-irrigated area, was perceived to be relatively wealthy. Community Diagnosis generated inclusive quantitative household data on health, incomes, and the environment. A comparison of results from quantitative and qualitative data showed a high degree of consistency. However, an inconsistency occurred in Mbui Njeru village where the qualitative data ranked malaria as the major health problem whereas the quantitative data from the Malaria Prevalence Survey, which was conducted during the wet season, showed no positive cases of malaria.

The Malaria Prevalence Survey results showed that the overall prevalence for the four villages was 23.5 per 100. Within the irrigated villages, the prevalence was 6.7 per 100, while in the non-irrigated villages it was 36 per 100, indicating that malaria prevalence was higher within the non-irrigated villages than within the irrigated villages. Relatively more males (68%) than females (32%) were positive for malaria parasites despite the roughly equal distribution of the sexes. Malaria prevalence was significantly related to the age and occupation of the household head, with those household heads that were that were in the

41-50 year age group and those that were unemployed/retired having the highest proportion of children with a positive blood slide. In addition, there was a significant relationship between malaria prevalence and type of house. The majority (78%) of children with a positive blood slide lived in temporary structures. There was no significant relationship between use of bed nets and a positive blood slide. However, there were significant differences in reported use of bed nets between irrigated and non-irrigated villages. More respondents in the irrigated villages reported that all household members used bed nets as compared to the non-irrigated villages. More respondents in the non-irrigated villages reported that they did not use bed nets at all.

There was a significant relationship between the use of anti-malarial drugs in the preceding three days and a positive blood slide. Most of the children who had used an anti-malarial drug had a negative blood slide.

The average number of *Anopheles arabiensis* mosquitoes in a house was significantly related to irrigation and to a positive blood slide. There was also a significant difference in the average number of *Anopheles arabiensis* mosquitoes in a house between irrigated and non-irrigated villages. Houses that had a lower average number of *Anopheles arabiensis* mosquitoes had a higher proportion of positive blood slides.

This cross-sectional survey only revealed the malaria situation at one point in time. Therefore, study that is more extensive is required in order to provide a wider picture of malaria in Mwea throughout the year. More research is necessary to explain the unusual difference in malaria prevalence between irrigated and non-irrigated villages. More work is also needed to investigate other findings such as the difference in prevalence between the sexes, and between villages with a predominance of cattle and those with a predominance of other types of livestock.

The symptoms of malaria are similar to those of other illnesses, notably typhoid, and this may partly explain the apparent inconsistency between qualitative and quantitative data on malaria prevalence observed in Mbui Njeru village.

Ecological development may have important effects on the epidemiology of vector borne diseases such as malaria. This may be particularly significant where disease transmission is unstable for example, in highland areas. Intersectional partnership is necessary, such as was the case in this study, in order to reduce the disease burden in Mwea. Understanding community perceptions of aetiology, symptom identification, and treatment of malaria is an important step towards control of the disease.

More detailed and ongoing research is vital if lasting solutions are to be found. Research projects should of necessity be participatory at all stages, such as was the case with the ICIPE-IWMI Project, and even more importantly, continuous, because of the need for monitoring, evaluation, and sharing of new information among concerned parties.

The residents of Mwea require empowerment in terms of acquisition of relevant health education and sound economic and business principles in order to improve their socio-economic status and therefore be able to adopt malaria-prevention measures.

1. Introduction

1.1 Introduction

In 1925 JL Gilks, the director of medical services of the Colony of Kenya, stated thus: 'The problem of the colonisation of Africa is the problem of malaria… and malaria is far and away the disease of outstanding importance in Kenya, both from the point of view of the mortality it causes, and the chronic debility attributable to it'. Then and even now, malaria still ranks as a disease of prime importance for the same reasons given in Gilks' statement. Approximately 20 million people in Kenya are exposed to stable malaria transmission, including 3.5 million children below the age of five years. Of the childhood population, approximately 26,000 die each year from the direct consequences of infection. In addition, pregnant women have an increased risk of severe anaemia and low birth-weight babies. Unstable malaria has also been increasing in frequency and severity since the 1980s, not forgetting the rapidly emerging resistance to first line drugs. There remains a lack of understanding of any empirical relation between the real frequency of parasite exposure, cross-sectional parasite prevalence, and age-specific disease outcome.[3] The importance of malaria cannot be over-emphasised and therefore continuing research is important in order to determine as many risk factors for malaria as possible in order to increase the effectiveness of intervention strategies.

In line with this, the Human Health Division of the International Centre of Insect Physiology and Ecology (ICIPE) in conjunction with the International Water Management Institute (IWMI) is presently carrying out a project in Mwea funded by the International Development Research Centre (IDRC) Canada. This project (Agro-ecosystem Management for Community-Based Integrated Malaria Control in East African Irrigation Schemes) –

hereafter referred to as the ICIPE-IWMI Project – aims at improving health and well-being of communities in irrigation schemes through the development of sustainable strategies for reduction of malaria and other health risks based on improved agro-ecosystem management. This is in line with the objectives of the WHO Global Malaria Control Strategy. The current study is part of the ICIPE-IWMI Project. Its purpose is to determine the prevalence and potential risk factors for malaria in Mwea, an area with mostly low stable malaria transmission, though at times the whole population is subject to unstable transmission. The selection of Mwea is relevant to the objectives of the ICIPE-IWMI Project, whose area of focus is irrigation schemes. Mwea being an important, if not the most important, irrigation scheme in Kenya is the most logical choice of study area for this project.

1.1.1 Background Information

For a long time, it was believed that malaria was caused by bad air found over fetid marshes (*mal aria* is the Italian term for 'bad air'). However, it is now known that the causative agents in humans are four species of *Plasmodium* protozoa: *P. falciparum, P. vivax, P. ovale,* and *P. malariae*. Of these, *P. falciparum* accounts for the majority of infections[1] and is the most lethal. The discovery of chloroquine made the world believe that the dreaded swamp disease had been conquered. Early in World War II the allies discovered that the Germans were testing a new anti-malarial in Northern Africa. Andersag, Breitner, and Jung had first synthesized Resochin®, later called chloroquine, in 1937 in Germany. Chloroquine showed itself to be active against schizonts of both *P. vivax* and *P. falciparum* and it was a good prophylactic agent. It was initially thought to be too toxic but the US Army eventually adopted it as a standard anti-malarial. Decades later the battle against malaria continues. Mosquitoes and malaria generally thrive among underprivileged communities which are usually affected by other environmental hazards and economic problems e.g. malnutrition, low living standards, and lack of medical care. Other traditional health hazards related to poverty and insufficient development include lack of access to safe drinking water, inadequate basic sanitation in the household and the community, food contamination with pathogens, inadequate solid waste disposal, and occupational injury hazards in agriculture and cottage industries.[4]

Clinical signs and symptoms of malaria include some or most of the following: fever, shivering, pain in the joints, headache, repeated vomiting, generalised convulsions, and coma. Severe anaemia (exacerbated by malaria) is often the cause of death in areas with intense malaria transmission. If not treated, malaria (particularly that caused by *P. falciparum*) progresses to severe illness, which may lead to death.

Female anopheline mosquitoes transmit malaria and their number and type determine the extent of transmission in a given area. Malaria transmission often coincides with the rainy season and is influenced by climate, environmental factors, ecological conditions, and geography.

1.1.2 Impact of Malaria and Irrigation

In African countries, the weather is extremely variable, and irrigation is seen as one obvious way to increase agricultural production. However, irrigation affects more than the crops that grow in farmers' fields. Research findings show that irrigation can also affect people's health. Malaria is a case in point. By increasing wet areas, irrigation can increase breeding grounds for mosquitoes, the main vectors of malaria. This, in turn, increases the probability that people living close by will catch the disease.[5]

Malaria exacts an enormous toll in lives, medical costs, and days of labour lost. However, if promptly diagnosed and adequately treated, malaria is curable. More than any other disease, malaria exerts the greatest impact on the poor, with rural communities being affected most. In rural areas, the rainy season is usually a time of intense agricultural activity, when poor families earn most of their annual income. Malaria can make these families even poorer. Malaria endemic countries are some of the world's poorest. Costs to countries include costs for control and lost workdays – estimated to be 1-5% of GDP in Africa.[1] For the individual, costs include those of treatment and prevention, and lost income. In children, malaria can lead to chronic school absenteeism and impairment of learning ability. Urban malaria is increasing due to unplanned development around large cities, particularly in Africa and South Asia.

1.1.3 Risk Factors and Re-emergence of Malaria

Over the past 50 years, the geographical area affected by malaria has shrunk considerably. However, control is becoming more difficult and gains are being eroded. Various causes of spread include disintegration of health services, armed conflicts and mass movement of refugees, and the emergence of multi-drug resistant strains of the malaria parasite. Imported cases of malaria are now more frequently registered in developed countries owing to the explosion of easy international travel. In addition, malaria is re-emerging in areas where it was previously under control or eradicated.[1]

In malaria endemic areas of the world, a change in risk of malaria may be linked to economic activity or agricultural policy that changes the use of land such as creation of dams, irrigation schemes, commercial tree cropping and deforestation. The proliferation of rice ecosystems in Africa has brought with it considerable health risks to populations in the areas.[6] These health risks are greatest due to exacerbation of diseases such as malaria, schistosomiasis, and typhoid. In addition, the large fresh water reservoirs associated with dams and irrigation systems throughout Africa are major transmission foci and thus endemic areas for these diseases. People are infected by contact with water used in normal daily activities such as personal or domestic hygiene and swimming, or by professional activities such as fishing, rice cultivation, and irrigation. Due to lack of information or insufficient attention to hygiene, infected individuals may contaminate their water supply with faeces or urine.[7]

'Global warming' and other climatic events such as *El Nino* play their role in increasing the risk of malaria. The weather disturbances linked to *El Nino* events influence vector breeding sites, and hence transmission of the disease. There has been an increase in malaria incidence in many areas during these extreme weather events. The disease has now spread to the highland areas of Africa. Moreover, the outbreaks may not only be larger but also more severe as the affected populations may not have high levels of immunity.

1.1.4 Current Global Picture of Malaria

Malaria is by far the most important tropical parasitic disease. It is second only to tuberculosis in terms of mortality due to a communicable disease.[1]

- Malaria is a public health problem in more than 90 countries, inhabited by 40% of the world's population (about 2.4 billion people). It is found throughout the tropical and sub-tropical regions of the world.[1,2]
- Worldwide prevalence is estimated to be 300-500 million clinical cases per year.
- More than 90% of all malaria cases are in sub-Saharan Africa.
- Mortality due to malaria is estimated to be over 1 million each year, most of which occur among young children in sub-Saharan Africa, especially in remote rural areas with poor access to health services. Malaria kills an African child every thirty seconds.[2] Other

high-risk groups are women during pregnancy, non-immune travellers, refugees, displaced persons, and labourers entering endemic areas.

- Political upheavals, economic difficulties, and environmental problems enhance malaria epidemics and contribute significantly to death tolls and human suffering.
- Malaria is endemic in a total of 101 countries and territories, most of them in Africa and the Americas.

1.1.5 Prevention of Malaria

The epidemiology of malaria in Mwea (and by extension, Kenya) is markedly variable. This reflects obstacles and progress made in control strategies. Efforts to promote personal protection suffer setbacks in sustainability despite apparent acceptability.[8] Prevention of malaria encompasses a variety of measures that may protect against infection or against the development of disease in infected individuals. Measures that protect against infection are directed against the mosquito vector. These can be personal (individual or household) protection measures e.g. protective clothing, repellents, bed nets, or community/population protection measures e.g. use of insecticides and environmental management. In spite of drug resistance, malaria is a curable disease. Although there is only a limited number of drugs, if they are used properly and targeted to those at greatest risk, death and disease can be reduced as has been shown in many countries. Whereas in the past malaria control depended on insecticide spraying, now the selective use of protection methods, including vector control, is proving cost-effective and more sustainable. So, whereas house spraying is now restricted to specific high-risk and epidemic-prone areas, increasing use is being made of insecticide-treated bed nets. The use of ITN is recommended as a tool for prevention of malaria morbidity and mortality. In a study on the Kenyan coast, the introduction of ITN led to significant reductions in childhood mortality and severe, life-threatening malaria among children aged 1-59 months. These findings confirm the value of ITN in improving child survival. In addition, The effectiveness and cost-effectiveness of indoor residual house spraying (IRS) and ITN against infection with *P. falciparum* has been compared in the highlands of western Kenya. The prevalence of *P. falciparum* infection amongst those not protected by either IRS or ITN was 13%. Sleeping under ITN reduced the risk of infection by 63% and sleeping in a room sprayed with insecticide reduced the risk by 75%. In addition, the economic cost per infection case prevented by IRS was US$9 compared to US$29 for ITN. These findings suggested that IRS might be both more effective and cheaper than ITN in communities subjected to low, seasonal risks of infection and should therefore be considered as part of the control armamentarium for malaria prevention.[10] Another study supports the use of residual spraying of rooms with insecticides and reports that this method achieved better results than ITN. The authors advocate the use of non-irritant insecticides (including their use on nets) to achieve high mosquito mortalities.[11]

The effect of community-wide use of ITN in engendering a 'mass effect', such that those not sleeping under ITN in the adjacent area are offered protection has been studied with varying results. However, in Kilifi, Kenya, one such study showed that increasing level of ITN usage within the area neighbouring each child was coupled to a decreasing risk of developing malaria, thus providing data in support of a mass community effect. This effect was significant for areas at distances of up to 1.5 km away from each child.[12]

These studies make a strong point for the use of residual house spraying and/or ITN as a means of protection against infection with *P. falciparum.* These methods should therefore be encouraged as a means of protection against malaria by the residents of Mwea, particularly in the non-irrigated villages where the prevalence of *P. falciparum* malaria was found to be highest. The susceptibility of the mosquito vector to insecticides will require continual monitoring in order to detect development of significant resistance.

Early diagnosis and prompt treatment is fundamental to malaria control especially in children and pregnant women, on whom malaria exacts its greatest toll. In many countries, most cases of malaria are diagnosed and treated in the home or by private sector practitioners, often incompletely and with irrational regimens. This speeds up the spread of parasite resistance to anti-malarial drugs, which in turn leads to a rise in the cost of treating uncomplicated malaria. However, the use of anti-malarial drugs in the prevention of severe malaria is gaining acceptance and is worth instituting in malarious areas. From the findings of a study carried out on the Kenyan coast, the authors recommended that an intervention that could effectively decrease malaria infection in primigravidae could have a major impact on the well-being of these women and their infants.[13] One such intervention is the intermittent administration of SP drugs (such as sulphadoxine-pyrimethamine [Fansidar®]) to pregnant women for malaria prevention. Intermittent presumptive treatment with sulphadoxine-pyrimethamine is an effectual, feasible strategy to reduce the risk of severe anaemia in primigravidae living in malarious areas. This benefit applied both to those who used ITN and to those who did not.[14] Since HIV is gaining importance, it must also be considered in any malaria treatment and prevention regimen. Intermittent treatment with SP is safe and effective for the prevention of placental malaria in pregnant primigravidae and secundigravidae in sub-Saharan Africa. In addition, administration of SP monthly during the second and third trimesters of pregnancy should be considered in areas of high HIV seroprevalence to avert the effects of maternal malaria on the newborn.[15]

Anti-malarial drug therapy has a part to play in reducing malaria morbidity and mortality. The relative efficacy of commonly used anti-malarial drugs has been compared in children aged 3-12 years presenting with uncomplicated malaria. Halofantrine was the most efficacious drug followed by sulphadoxine-pyrimethamine (Fansidar®), amodiaquine, and chloroquine. Chloroquine showed the highest resistance and halofantrine the lowest.[16] Another study reported comparable efficacy between Metakelfin® (an SP drug) and halofantrine. The study concluded that halofantrine was a viable drug in the treatment of uncomplicated *P. falciparum* malaria.[17] Whenever possible it would be advisable to employ efficacious drug therapy in the treatment of malaria. The value of chloroquine in the treatment of malaria has diminished to the point that it is no longer recommended as first line anti-malarial treatment.[18]

Various global efforts are underway to combat malaria. Notably the WHO, among other private and public initiatives, spearheads these efforts.

The control of malaria depends on many factors, among them community perception of the causes and symptoms of malaria, and treatment behaviour. One study in Baringo district, Kenya, concluded that understanding community perceptions of aetiology, symptom identification, and treatment of malaria is an important step towards the control of the disease.[19] In Mwea, a similar study was carried out to investigate the treatment seeking behaviour for malaria.[20] This is a fundamental step in formulating strategies for the control of malaria in the region.

Other malaria intervention strategies that may gain more importance in the future are those that seek to predict malaria seasons and map out transmission and geographical distribution of malaria. Research is currently going on that predicts the seasonality of malaria in Kenya with a view to compiling national strategies for malaria intervention.[21] This would go a long way in providing some form of early warning system so that malaria control measures could be put in place in time to prevent epidemics.

Malaria control is everybody's business and everyone should contribute to it, including community members and people working in education, environment, water supply, sanitation, and community development. It must be an integral part of national health development. Community action for control must be sustained and supported by intersectional collaboration at all levels and by monitoring, training, evaluation, and operational and basic research.

1.1.6 Malaria Prevalence in Kenya

Kenya covers an area of 582,000 square kilometres. It borders Ethiopia in the North, Sudan in the Northwest, Uganda in the West, Tanzania in the South, and Somalia in the East. It lies between latitude 3°N and 5°S and between longitude 34° and 41°E. It is entirely within the equatorial zone and is approximately bisected by the equator. The country falls within two distinct regions: lowland and highland. This distinction affects the climate, patterns of human settlement, and agricultural activities. Only 1.9% of the total surface area is occupied by standing water. There are seven principal climatic regions in Kenya:

1. Modified Equatorial Climate of the Coast;
2. Modified Tropical Climate of the Kenya Highlands;
3. Modified Equatorial Climate of the Lake Victoria Basin;
4. Modified Equatorial Climate of the North Western Border;
5. Tropical Climate of Narok and Southern Taita and Kwale Areas;
6. Tropical Continental/Semi-Desert Climate of Eastern Kenya;
7. Desert Climate of Central Northern Kenya.[22]

These variations in climate have an impact upon the distribution of malaria vectors. Vector-man contact is enhanced by higher ambient temperatures. Low temperatures limit mosquito larval development thereby affecting adult abundance. Moreover, rainfall patterns determine the timing and magnitude of local vector proliferation.[23]

In Kenya, the most recent purely randomly sampled malaria prevalence surveys from various locations were included into a climatic model aimed at predicting the levels of endemicity. Communities were classified based on childhood parasite prevalence. Transmission intensity was classified as high if the childhood parasite prevalence was greater than, or equal to, 70%, intermediary intensity if it was between 20 and 69%, and low intensity if it was less than 20%. A level of less than 0.05% was classified as unstable transmission. Locations falling within the unstable transmission regions are limited by either temperature or rainfall. They include the northern and eastern borders, the area around Lake Turkana, the highland areas of western Kenya, and parts of Nairobi. These areas are nevertheless subject to epidemics when climatic conditions are optimal for localised transmission. Locations where transmission is of low intensity, mostly bordering the unstable areas, include the central part of northern Kenya, northern parts of the Coast Province, southern parts of Eastern Province, and central parts of the Rift Valley Province. Locations with a high intensity of transmission include the areas surrounding Lake Victoria and the southern coastal border with Tanzania. Parts of western Kenya, the areas bordering Uganda, Sudan, and Ethiopia, and parts of southern Kenya experience intermediary intensity of transmission. In summary, the distribution by population is as follows:

30% resided in areas of unstable transmission; 18% in areas of low transmission, 38% in intermediary, and 14% in areas of intense (high) transmission.[24]

Recent epidemiological data in Kenya demonstrate that the burden of morbidity and mortality is concentrated among the youngest age groups especially under conditions of intense stable transmission. In regions of less intense unstable transmission, the clinical patterns of disease are more life-threatening e.g. cerebral malaria.[25,26]

In Kenya, approximately 26,132 malaria deaths occur among children below five years of age during each non-epidemic year. This amounts to approximately 72 childhood malaria deaths a day.[1]

Another significant cause of morbidity is the effect of *P. falciparum* infection in pregnancy, whereby the risk of anaemia is increased. With intermittent presumptive treatment of pregnant women, the risks of complicated malaria would be reduced.

Reducing the morbid and fatal consequences of *P. falciparum* infection rather than parasite eradication represents the most realistic goal for much of sub-Saharan Africa.

1.2 Problem Statement and Rationale

As alluded to in earlier, the ICIPE-IWMI Project aims at improving health and well-being of communities in irrigation schemes through the development of sustainable strategies for reduction and control of malaria and other health risks. During the preliminary survey that was recently conducted in the Scheme to assess farmer knowledge and perceptions on malaria, respondents ranked malaria as the main health problem amongst other diseases such as typhoid, intestinal worms, and schistosomiasis [Mutero, 2000].[27] A logical starting point would be to assess the magnitude of the problem i.e. determine the prevalence of malaria. In addition, it has traditionally been assumed that communities living close to irrigation schemes necessarily have higher malaria prevalence. Previous studies in Mwea do not compare malaria prevalence in the irrigated sections with that in the non-irrigated sections. This is important in the light of recent findings that suggest that irrigation per se does not necessarily increase the malaria risk among the communities resident within such schemes.[28] In comparing the prevalence of malaria between irrigated and non-irrigated villages of Mwea, this study would therefore determine whether these recent findings apply to Mwea as well. Knowledge of the prevalence and determinants of malaria in Mwea is therefore an important aspect. This study aimed at determining the prevalence of malaria and assessing the potential environmental and socio-economic determinants of the disease in Mwea. In addition, it is not clear whether rice irrigation per se constitutes a greater risk factor for malaria than other factors such as livestock, socio-economic status, and use of anti-malarial measures as suggested by various studies cited in this document. The determination of prevalence and risk factors for malaria would facilitate planning and increase the effectiveness of control and intervention strategies in Mwea. The knowledge obtained would facilitate equitable allocation of resources to the affected areas. In addition, knowledge of the relationship between malaria and various environmental and socio-economic factors allows for a much more focused approach to intervention and control. Consequently, the relevance of this study cannot be overemphasized.

1.3 Study Objectives

1.3.1 Research Question

- Is there a difference in the epidemiological indicators of malaria between communities that are resident within the irrigated sections and those in the non-irrigated sections of Mwea Division, Kirinyaga District?

1.3.2 Hypothesis

The null hypothesis stands as follows:

- There is no difference in the prevalence of malaria between communities that are resident within the irrigated sections and those in the non-irrigated sections of Mwea Division, Kirinyaga District.

1.3.3 Objectives

1.3.3.1 Broad Objective

- To undertake a comparative assessment of the potential environmental and socio-economic determinants of malaria among children in Mwea Division, Kirinyaga District.

1.3.3.2 Specific Objectives

1. To determine the socio-demographic characteristics of the study population in irrigated and non-irrigated villages;

2. To determine the prevalence of malaria among children in irrigated and non-irrigated villages;

3. To compare the prevalence of malaria between irrigated and non-irrigated villages;

4. To determine the possible risk factors for malaria among the study population.

2. Literature Review

2.1 Relevant Local Studies

A study in 1984 and 1985 showed that *Anopheles gambiae* and *Anopheles pharoensis* were the major anophelines in the Mwea-Tebere Irrigation Scheme, Kenya, (hereinafter referred to as 'the Scheme'), constituting 83.86% and 15.69% of the catch respectively.[29] The irrigation phase of the rice cultivation cycle (in August) which linked the flooding effects of the two rainy seasons resulted in major population increases of *Anopheles pharoensis* and enabled continuous breeding for up to 9 months per year. *Anopheles pharoensis* can contribute to the epidemiology of malaria in the Mwea area.[29] *Anopheles arabiensis* and *Anopheles funestus* were identified as vectors of *Plasmodium falciparum* malaria in the Scheme with *Anopheles arabiensis* being the predominant species.[30]

The flooding of land during rice cultivation has often resulted in an increase in the prevalence of malaria and other vector and water-borne diseases.[31] In Kenya, research in an irrigated area has shown a 70% increase in the number of malaria vectors biting people, compared to nearby non-irrigated areas.[32] Rice is generally grown under continuous soil submergence, which maintains healthy plants and provides high grain yields.[33] Flooding affects the physical characteristics of rice plants, the nutrient status and physio-chemical characteristics of the soil, improving the availability of nitrogen and phosphorus.[34] Submergence of rice fields also helps to control weed growth. It is easier for the farmer to grow rice under continuous submergence although it is not essential for rice cultivation.

In irrigated areas where the local anopheline populations also feed on animals, livestock are perhaps the next most important agro-ecological determinants of malaria risk after the mosquito-breeding habitats. Livestock, especially cattle that are present in most irrigation schemes, can play a significant role in malaria transmission since certain mosquito vectors readily feed on them.[35] In certain parts of the world, a reduction in draught animals and other livestock has sometimes been accompanied by an increase in mosquitoes biting man with significant consequences for the malaria situation. Giglioli[36] described such a change, leading to the detriment of human health in Guyana.

A preliminary survey was recently conducted in the Scheme to assess farmer knowledge and perceptions on malaria, [Mutero, 2000].[37] Respondents ranked their priorities as follows: hunger (80%), diseases (66%), and poverty (41%). Malaria was ranked as the main health problem amongst other diseases such as typhoid, intestinal worms, and schistosomiasis. Based on these preliminary findings, it is obvious that the majority of traditional health hazards including malaria are closely linked to the household environmental and socio-economic conditions. Indeed, socio-economic differences may affect the immune status.[37] In Kenya, it was found that at a certain threshold of income, the situation becomes favourable for adoption of malaria control measures at family level, and this goes hand in hand with improvement of the living standard of the family or community.[38] Therefore, a community with relatively higher economic development would be associated with greater use of anti-malarial measures, and within a community, wealthy individuals would be more likely to use such measures.[39,40]

A study[41] was conducted in the Scheme between April 1989 and February 1991 to determine, among other things, the impact of rice irrigation practices on malaria infection rates in both the human and mosquito populations. Two villages, Mbui Njeru and Mathangauta, were selected because of their accessibility and contrasting conditions. The former is located within the rice paddies while the latter lies at the periphery and is only adjacent to the paddies on one side. Malaria parasite prevalence rate in the human population for Mbui Njeru and Mathangauta was less than 8.7% for all age and sex groups. The overall malaria prevalence rate was found to be less than 7.6% for all the villages screened within the irrigation scheme. The overall parasite prevalence rate in Mbui Njeru was 6.3% and 3.7% [$F_{1,1} = 6.27$; $p < 0.01$] for males and females respectively. The peak malaria prevalence rate occurred in the month of July for both villages. The malaria prevalence rate for Mbui Njeru was higher than that for Mathangauta [$F_{1,1} = 12.63$; $p < 0.01$]. An observation that could probably be the reason for a higher prevalence rate in Mbui Njeru is that during the rice growing cycle, the paddies are flooded much earlier and for longer (March to December each year). In contrast, the paddies adjacent to Mathangauta are flooded later and therefore for a shorter time each year (July to December). The higher infection rate in males (6.3%) than in females (3.7%) could probably be due to the social and cultural behaviour of males who stay outdoors for a longer period in the evenings (and are thus exposed to transmission for a longer period) than females. The malaria prevalence rates among the different age groups were compared and it was observed that they were highest in infants below 11 months. The study also showed that the numbers of mosquitoes were large enough to maintain malaria transmission throughout the year in the area studied. The results on the difference in the malaria prevalence rates in the separate villages were significantly different, with villages situated in the middle of the paddies showing a higher prevalence rate than those situated at the periphery. The difference observed in malaria prevalence rate among the age and sex groups was not significant.

2.2 Relevant Regional Studies

Biritwum, Welbeck, and Barnish studied the incidence of malaria in two communities of different socio-economic level, in Accra, Ghana.[42] El Samani, Willett, and Ware studied nutritional and socio-demographic risk indicators of malaria in children under five in a cross-sectional study in a Sudanese rural community.[43] Both studies demonstrated or suggested a link between socio-economic status and malaria. This link should be explored further in order to make it clear which of the proxy indicators for socio-economic status actually affect this relationship.

A study to assess the impact of construction of micro dams on the incidence of malaria in nearby communities was conducted in the Tigray region in northern Ethiopia in 1997. The subjects were about 7000 children under 10 years living in villages within 3 km of micro dams and in control villages 8-10 km distant. The main outcome measure was incidence of malaria in both communities. The results showed that the overall incidence of malaria for the villages close to dams was 14.0 episodes per 1000 child-months at risk compared with 1.9 in the control villages, a sevenfold ratio. Incidence was significantly higher in both communities at altitudes below 1900m.[44]

However, a recent review article brings to light the fact that rice irrigation does not necessarily lead to increase in malaria prevalence and states that recent studies in Africa have revealed a more complex picture showing that in most cases, irrigation schemes in Africa do not appear to increase malaria risk, except in areas of unstable transmission.[28] Studies in the Lower Moshi Rice Irrigation Scheme, Tanzania showed that malaria prevalence was four times lower in children living near irrigated rice cultivation compared with a nearby savannah village.[39] When measurements of the vectorial capacity of *Anopheles arabiensis* and *Anopheles funestus* were used, the potential risk of malaria was fourfold higher in villages within rice fields as compared to those within sugarcane or savannah villages nearby. However when a more precise estimate of malaria risk based on entomological inoculation rates was used, it was found that exposure to infective vectors was 61-68% less for people in villages within rice fields as compared to those in sugarcane or savannah villages nearby.[45] In The Gambia, the introduction of a large-scale rice irrigation scheme led to anecdotal reports of increased malaria in local communities. However, on closer examination, it was apparent that there was less malaria near the rice field than in other rural communities.[46]

2.3 *Studies beyond Africa*

A cross-sectional study to identify the socio-economic and environmental protective/risk factors for severe malaria was carried out in Thailand. Forty-six cases of severe malaria, 72 cases of non-severe malaria with high parasite biomass and 40 mild malaria cases were included. When comparing severe malaria and non-severe malaria with high parasite biomass, specific logistic regression models showed a significant protective effect for helminths and for low body mass index (BMI). When comparing severe and mild malaria, longer residence duration and the use of anti-malarial self-medication were associated with protection from severe malaria.[47] Patients with severe malaria were older, richer and had a higher BMI than those who did not have severe malaria. They seemed to wait longer for treatment and were more often non-immune. The knowledge about the potential severity of malaria did not seem to differ between cases and controls. Although the sample size in this study was small, the researchers claim that the different comparison groups used allowed them to differentiate factors influencing parasite multiplication or the probability to encounter a virulent strain and factors influencing cytoadherence of parasitised red blood cells. Longer residence duration in the area where malaria was contracted was associated with protection from non-severe malaria with high parasite biomass and severe malaria, possibly reflecting the underlying strain specific immunity of patients living in an endemic area. They did not detect any significant difference in the residence duration when comparing non-severe cases with high parasite biomass and severe cases. An interpretation of this would be that in a semi-immune population, the specific immune response might have conferred protection against a number of virulent strains. This immunity was therefore against both non-severe malaria with high parasite biomass and severe malaria. However, when a virulent strain was not recognised, specific immunity did not protect from complications. Using the mild malaria control group, self-medication and residence duration appeared to be protective against severe malaria. Both self-medication and residence duration reduced the chance of developing severe malaria possibly by hampering parasite multiplication. Helminth infections and probably low BMI seemed to have a more specific effect on the pathogenesis of severe malaria. House spraying with DDT seemed to be associated with protection against both severe malaria and non-severe malaria with high parasite biomass.[47] Other studies failed to detect any relation between inoculation rates or the entomological density and malaria severity.[48 49] These discrepancies may be linked to the difficulties in detecting a significant effect when the transmission is low. Helminths and low BMI were significantly more frequent in the non-severe with high biomass group than in mild malaria. This suggested that in this subgroup, presumably infected by a virulent strain but without cytoadherence related complications, the prevalence of a protective factor was higher than in the mild malaria group, which was more likely to be infected by a non-virulent strain. On the contrary, a long residence duration and house spraying were more frequent in the mild malaria group confirming the hypothesis of their protective effect on parasite multiplication and the probability to encounter a virulent strain respectively. Altogether, the above-given results give an overview of the diversity of factors leading to severe disease in Thailand and their interactions with the socio-economic status. The combination of comparisons between severe cases with both non-severe cases with high parasite biomass and mild cases may give interesting information on the stage affected by the risk/protective factors in the sequence leading to severe disease.[47]

From the foregoing, it is clear that a number of factors affect malaria transmission and development. The studies cited above provide scope for further research into the actual relationships that may be present between malaria and the presence of livestock, notably cattle. The irrigated villages of Mwea provide such an eco-system, where man co-exists with livestock in an irrigated area. In addition, the study on vectors reveals that *Anopheles arabiensis* was the predominant species in the irrigated villages of Mwea. This species is zoophilic and thus prefers to feed on cattle. With these determinants in place, Mwea is thus well suited for the exploration of this relationship.

The study on malaria prevalence did not compare the prevalence in irrigated and non-irrigated areas. Undoubtedly, this comparison would provide useful insights into the real effect of rice irrigation on the prevalence of malaria.

Overall, the studies raise relevant issues, all aimed at increasing the understanding of the various relationships revolving around the transmission of malaria and its development in susceptible hosts. It remains to be seen whether these conclusions would hold in the face of findings of future studies in Mwea and similar ecosystems.

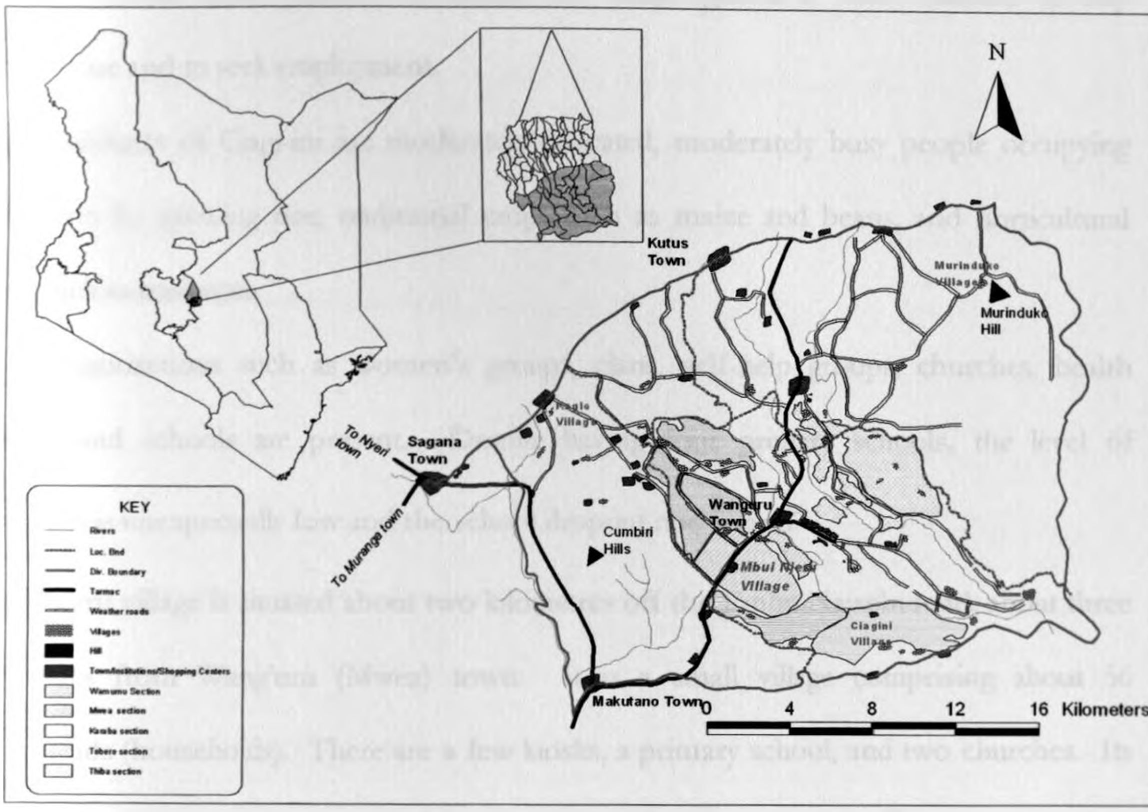
3. Study Methodology

3.1 Study Site

Mwea is situated approximately 100 kilometres Northeast of Nairobi near the foothills of Mount Kenya at an altitude of 1,159 meters above sea level. It is 0°40′ South of the Equator and 37°18′ East of the Prime Meridian. The mean annual rainfall is 950 mm with maximum amount falling in April/May (long rains) and October/November (short rains). Within Mwea lie a number of villages and townships. Some of these lie within the irrigated areas while others lie within the non-irrigated areas. The Mwea Irrigation Scheme lies within the irrigated area of Mwea. The Scheme covers an area of about 13,640 hectares, 45% of which is used for paddy cultivation. The remaining area is used for subsistence farming, grazing, and communal activities.[50] There are about 3,100 farmers accommodated in the Scheme. All farmers live in 36 villages on the Scheme and each village is located as centrally as possible in relation to the farmers' holdings. Until recently, the NIB provided the farmers with farm inputs as well as farming and crop processing facilities on a loan basis. However, a community-driven multi-purpose co-operative society has taken over some of the functions of the NIB in what might lead to the creation of a new management system for the Scheme. The Scheme falls within a zone of low but stable malaria transmission, characterised by a parasite prevalence of less than 20% in the human population.[3] Figure 3.1 below illustrates Mwea Division. The study villages are highlighted in red.

Study villages within the irrigated area included Ciagi-ini and Mbui Njeru and those within the non-irrigated area included Kagio and Murinduko.

FIGURE 3.1 – MAP OF MWEA DIVISION



Ciagi-ini village borders Mbeere District in Eastern Province. A canal, (Thiba Branch Canal IV), separates the village from the paddy fields. Settlement in the area began in the early 1970s. The inhabitants live in cluster plots measuring 50ft × 100ft or 25ft × 50ft in size. The village is ethnically heterogeneous, as people from the surrounding administrative divisions and districts inhabit it. The only water supply scheme in Ciagi-ini village stopped operating in 1998 following the withdrawal of the NIB (National Irrigation Board), which also confiscated the water pumping facility that pumped water to elevated tanks within the village.

The village is administered by the Provincial Administration assisted by village elders. The highest administrative office in the village is that of Assistant Chief. Commercial activities are carried out within market centres in Ciagi-ini. These centres generally comprise retail shops, butcheries, hotels, and open-air markets offering various consumer goods and services. People from within and outside the village gather at these markets to buy merchandise and to seek employment.

The inhabitants of Ciagi-ini are moderately educated, moderately busy people occupying themselves by growing rice, traditional crops such as maize and beans, and horticultural crops such as tomatoes.

Social organizations such as women's groups, clans, self-help groups, churches, health centres, and schools are present. Despite having four primary schools, the level of education is unexpectedly low and the school dropout rate is high.[51]

Mbui Njeru village is situated about two kilometres off the Embu-Nairobi road, about three kilometres from Wang'uru (Mwea) town. It is a small village comprising about 56 homesteads (households). There are a few kiosks, a primary school, and two churches. Its relatively modest development may be due to its close proximity to Wang'uru town, to which most people would probably go for most of their requirements.[52]

Kagio, a key commercial centre, is situated along the Kutus–Sagana main road. There are several shops, bars and restaurants, private medical clinics, a market place, and churches. Most of the population in Kagio comprises teachers, traders and businesspersons, drivers and touts, farmers (who have land on the outskirts of Kagio), and green grocers. These farmers practice horticulture of French beans and tomatoes and subsistence farming, mainly of maize and beans. Most of the people living in Kagio were not born there but settled there to do business or because they were employed there.[53]

Murinduko village is situated about three kilometres off the Embu – Nairobi road, the turn-off being a few kilometres from Embu town. The village was established in July 1954 during the colonial period. The village, which covers a stretch of approximately three kilometres, forms the eastern boundary of Central Province. It neighbours Mbeere district in Eastern province with the Rupingazi River forming the administrative boundary between the two. The village experiences dry spells for most of the year. This is probably because it is located on the leeward side of Murinduko hill, which neighbours the village. As one moves from the Embu – Nairobi road into the interior, the agro-ecological zones change drastically with conspicuous socio-economic indicators of low purchasing power. Soil erosion and poor soils are common in the village, which currently has an estimated population of 5,000. The population is increasing at the same time as resources are being overexploited. Currently the government is in the process of issuing the inhabitants with title deeds. The village is lagging behind in terms of infrastructure and health services. Murinduko Dispensary, which is located at the centre of the village, does not adequately address the health needs of the village. Most of the local people are low-income earners with low purchasing power. Most households earn KShs 80 per day from casual employment. Murinduko is one of the poorest areas in Mwea and ironically, the villagers never receive relief supplies unlike other regions in the division. Due to the poor weather conditions (which do not favour agriculture), the people depend largely on the little cash they get from casual labour in the surrounding regions.[54]

3.2 *Study Design*

This was a cross-sectional study, in which prevalence was compared between irrigated and non-irrigated villages of Mwea. Being a cross-sectional survey, data was collected over a relatively short period. The study population was assessed with respect to the presence or absence of malaria as well as prior exposure to risk factors, at the same time. The study utilized both qualitative and quantitative methods of data collection. A cross-sectional study was selected for the following reasons:

- A cross-sectional study design is ideal for the estimation of disease frequency, which was one of the objectives of the study;
- Cross-sectional studies minimize manipulation of the study factors by the investigator;
- Little was known about the occurrence and determinants of malaria in Mwea;
- It was the most feasible study design given the resources available in terms of time and finances;
- Cross-sectional studies are carried out in settings that are more natural and therefore the study population is more representative of the target population.

The last point is important for health planners who base their decisions on findings of epidemiological studies.

3.3 Study Population

The study population for the quantitative Malaria Prevalence Survey and the Community Diagnosis comprised children nine years of age and below and household heads (or their representatives) respectively. A demographic listing of the households within the selected villages was used in order to establish those households that had children below nine years of age. This age group was selected because in malaria endemic areas the pattern of infection shows a decline in the infection rate with age,[55] reflecting increased immunity in older people. Thus, older age groups are unsuitable for such a comparative study.

The study population for the qualitative methods comprised two main groups:

i) A representative group of the local society that held a stake in one way or another in Mwea (for the Stakeholders' Consultative Workshop);

ii) Representatives of women's, men's, and youth groups respectively, from each village (for the PRA).

3.4 Selection of Study Areas

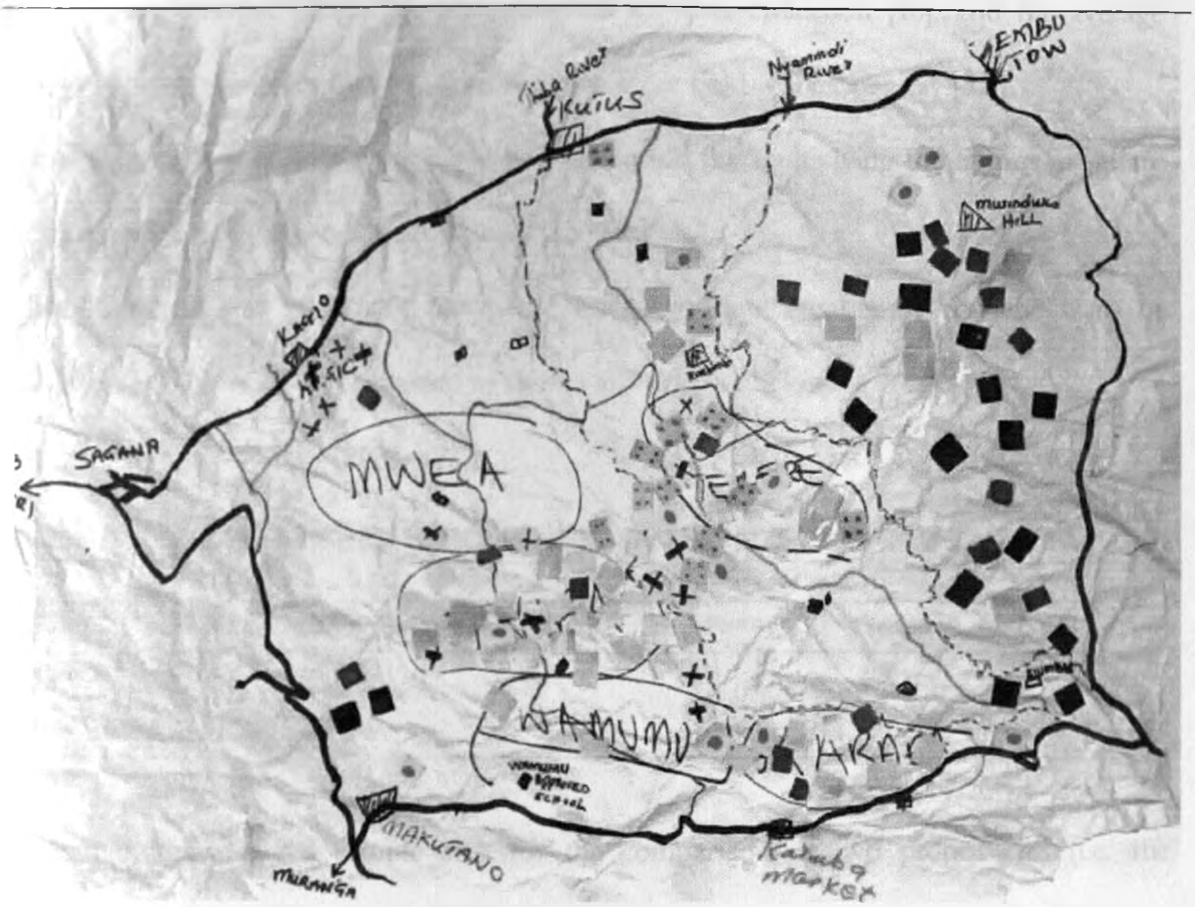
A visual process in which key problems were spatially distributed on a map of Mwea guided the selection of study areas, covering both irrigated and non-irrigated villages. The problems identified were colour-coded by assigning each a different colour (refer to *3.6.3* below). The participants pasted index cards of the respective colours onto the map in areas they perceived as most affected by the particular problem. This produced a pattern with problem concentrations in different villages (Plate 3.1). The problem concentrations helped define occupational systems (irrigated and non-irrigated) and socio-economic status (poor and less poor). Based on these patterns, the project study villages were identified as follows:

- Mbui Njeru: Irrigated, not poor;
- Ciagi-ini: Irrigated, poor;
- Murinduko: Non-irrigated, poor, high levels of malnutrition;
- Kagio: Non-irrigated, high socio-economic status.

3.5 Sampling and Sample Size

Purposive Sampling[56] was used to select the villages, based on the considerations in *3.4* above. The sampling unit was the household. For the purposes of this study, a household was defined as those who cook and eat together and have done so continuously for the past three months or longer. The serial listing of the households formed the sampling frame, which included 684 households. Proportionate Probability Sampling (PPS) based on village size was used to determine the number of households to be visited per village. Simple Random Sampling using a random number generator was used to select individual households.

PLATE 3.1 – STAKEHOLDERS' PROBLEM CHART



KEY TO PLATE 3.1

Poor Drinking Water	Poverty
Malaria	HIV/AIDS
Alcoholism	Ignorance
Poor Nutrition	Lack of Sewerage Systems

There were four villages included in the study. Two of these (Ciagi-ini and Mbui Njeru) are situated within the irrigated area and two (Murinduko and Kagio) outside the irrigated area.

The sample size estimation for the ICIPE-IWMI Project considered the number of villages [4], field workers per village [3], days allocated for data collection [10], and the average number of questionnaires that could be completed per field worker per day [3.5].

From these considerations, the sample size was found (by multiplying the figures in square brackets) to be 420 households i.e. 4*3*10*3.5 = 420.

Using Proportionate Probability Sampling, the appropriate number of households to be sampled in each village was obtained as shown in Table 3.1 below.

TABLE 3.1 - NUMBER OF HOUSEHOLDS AND SAMPLE SIZE

	Ciagi-ini	Kagio	Mbui Njeru	Murinduko	TOTAL
Number of Households	249	127	52	256	684
Sample Size	153	78	32	157	420

To obtain the required sample size for the comparison of two proportions (i.e. the comparison of malaria prevalence between irrigated and non-irrigated villages) the following formula was used:

$$n = \frac{(u+v)^2 \{p_1(100 - p_1) + p_2(100 - p_2)\}}{(p_1 - p_2)^2},$$

where: n = sample size;

p_1, p_2 = proportion of people with the variable of interest in the two populations to be compared;

u = one sided percentage point of the normal distribution corresponding to 100% minus the power (in this case 90%, giving a value for u of 1.28)

v = percentage point of the normal distribution, corresponding to the two-sided significance level (in this case 5%, giving a value for v of 1.96)

Rapuoda[41] obtained a malaria prevalence of less than 7.6% for two irrigated villages in Mwea. Data from the DOMC malaria blood slide results for Kirinyaga District indicated that the average annual malaria prevalence rate was 34%. Substituting these two figures for p_1 and p_2 in the formula above, the sample size required from each area (irrigated and non-irrigated) to demonstrate a significant difference with 90% likelihood, was 45 children. Note that in the absence of an estimate for one of the regions under study, it is conventional to use 50% as the estimate. If this were used instead of 34%, the required sample size would be even smaller. To increase the precision of the comparison, all children nine years of age and below in the selected households were targeted, giving a sample of 286 children for all villages, with 112 from the irrigated villages and 174 from the non-irrigated villages.

3.6 Data Collection

3.6.1 Variables

The dependent (outcome) variable was presence of malaria parasites in the blood of a subject.

The independent (predictor) variables included section of Mwea (irrigated or non-irrigated), age of subject; sex of subject, age of the household head, sex of the household head, level of education of the household head, and socio-economic status (based on various proxies of socio-economic status such as occupation of the household head and type of house). For the purposes of this study, 'type of house' was classified into permanent, semi-permanent, and temporary structures. If a house had a roof made of iron sheets or roofing tiles, a cemented or wooden floor, and stone, red brick, or concrete walls then it was considered permanent. If it had a roof made of iron sheets or grass, an earthen floor, and mud walls or walls consisting of iron sheets then it was considered temporary. All other combinations in between these were considered semi-permanent.

Other independent variables included distance between cowshed and living quarters, use of bed nets, screened/'unscreened' windows and eaves, and the average number of *Anopheles arabiensis* mosquitoes in a house.

The rationale for the use of these variables was their significant relationship to malaria as shown by a study conducted in a malaria zone in Kenya.[57]

3.6.2 Personnel

Ten field assistants were trained on the following:

1. Participatory Rural Appraisal (PRA) technique;
2. Contents of the questionnaires i.e. questions and the expected responses;
3. Procedure for administration of the questionnaire i.e. courteous approach including an explanation of the purpose of the study and completion of the questionnaire with correct entry of responses;
4. The need for and importance of reliable and valid data.

The principal researcher supervised and edited the data collection for the Malaria Prevalence Survey. Other ICIPE-IWMI Project researchers supervised and edited the data collection for the PRA and Community Diagnosis. This entailed attending the interview session with the assistants in order to ensure accuracy. The raw data was edited again, coded, and tabulated before entry.

3.6.3 *Instruments*

Both quantitative and qualitative data-collection methods were used.

<u>Qualitative methods:</u>

- A two-day Stakeholders' Consultative Workshop was held on 30th-31st January 2001. The aim of the workshop was to understand health and related development issues as perceived by the people of Mwea. Twenty-three participants representing seventeen groups and organizations attended the workshop. A participatory process was used to define the agenda for the workshop, identify and rank problems, and to decide on the study areas. This process was facilitated by the use of index cards clustered by themes, group work, and brainstorming. For example, in ranking problems, each participant wrote on an index card what they considered the most pressing problem in the area. The number of cards for each problem determined its gravity and therefore the ranking. Through group work, these problems were discussed further in terms of causes, effects, and strategies that could be used to address them.
- A Participatory Rural Appraisal (PRA) was conducted in April and May 2001 in each of the study villages. This involved utilization of the following tools:
  - Community Mapping which identified the layout of the community, laying emphasis on aspects such as houses, shops, churches, farmlands, domestic water sources, cattle dips, boundaries, educational and health facilities, and population.
  - Time-related tools such as trends, timelines, and daily, weekly, and seasonal calendars.
  - Focus group discussions (FGDs), in which the key people included facilitators, recorders, and participants. These discussions were held with a small group of people, such as women or youth, who shared common concerns. They served as a forum for addressing a particular issue. In addition, they provided an opportunity to

crosscheck information that had been collected using other techniques and to obtain reactions to hypothetical or planned interventions.

The previously trained field assistants, drawn from each of the four villages, assisted with the gathering of data. The use of local people as field assistants, apart from being a token of appreciation for the time devoted to the project by community members, was desirable due to the advantage of using local people who knew the area and the people well.

Using the above tools, data on health and other development issues were collected. The use of a wide variety of tools and sources helped check the consistency and accuracy of information.

Data was collected from each of the groups mentioned in *3.3* as the target groups for PRA. After compilation of data, the teams presented the results to respective communities to validate the information gathered. The communities reviewed, discussed, and made amendments to the data as necessary. The process of validation was necessary to ensure that data collected were both accurate and comprehensive.

In order to gain further insights into health and development issues identified through participatory processes, a comprehensive Community Diagnosis was carried out in the selected sample of households in all the four study villages, using a questionnaire. The diagnosis gathered information on diverse variables as indicated in *3.6.1*).

<u>Quantitative methods:</u>

- Information pertaining to what is listed above as independent variables (under *3.6.1*) was obtained by means of a questionnaire with open and closed-ended questions as per Appendix 2. The field assistants administered the questionnaire, within selected households in the four villages. Mosquito sampling was initiated in August 2001 and carried on until June 2002. Eleven houses were sampled monthly in each village. The protocol for mosquito sampling was as follows: eleven houses were selected randomly from the study sample in the four villages for collection of adult mosquitoes. These were collected using the Pyrethrum Spray Catch (PSC) technique (WHO, 1975). The floor of the house to be sampled was covered with white fabric sheets. An emulsifiable pyrethrum extract was diluted with water to obtain a 3% solution. All the windows were shut and the house was sprayed with this solution, from the exterior to the interior. The door was then closed. After ten minutes, the white fabric sheets were carefully folded up and removed from the house. All the mosquitoes that had dropped onto the sheets were collected and placed in specimen bottles, and later separated according to species. Blood meals from these were then analysed to determine the source of blood.

- In December 2001, the Malaria Prevalence Survey was carried out. All the children nine years of age and below in selected households along with their parents/guardians were asked to gather at a central place in the respective village. A return visit to Kagio in February 2002 was necessary due to poor response during the first visit. During the return visit, each selected household in Kagio was physically visited in order to improve the response rate. Information on malaria prevalence was obtained by preparation of blood films on glass slides using peripheral blood drawn from finger pricks in order to ascertain the presence of malaria parasites. After staining with Giemsa, the films were examined under a microscope. Qualified laboratory technicians from the DVBD at Kimbimbi Sub-district Hospital performed this task. If the film was positive for malaria parasites, the patient received medical treatment only if they were not already receiving treatment. A community nurse dispensed the appropriate medication.

In this study, a case of malaria was defined as follows:[58]

- Blood slide positive for malaria parasites, with or without fever or history of fever lasting a few days. This was the major criterion.

If in addition to the above criteria they showed any of the following additional symptoms, then they were considered to be suffering from severe malaria:

- Unconsciousness;
- Rapid/difficult breathing;
- Pallor of hands, tongue, and eyelids;
- Convulsions/fits;
- Inability to feed/vomiting;
- Dehydration

That fever is a good indicator of malaria and that caretakers are reasonably accurate in establishing raised body temperature has been shown. Febrile episodes are often the starting point for malaria and most other endemic diseases in children in tropical countries and serve as useful diagnostic and prognostic markers. A report of fever, especially in children, in combination with other symptoms that suggest malaria, should initiate treatment. The benefits (such as prevention of severe and life-threatening malaria) are obvious and outweigh the disadvantage of indiscriminate use of anti-malarial drugs, which is often blamed for the development and spread of drug-resistant malaria.[59,60,61,62,63]

PLATE 3.2 – THIBA HEALTH CENTRE NEAR WANG'URU (MWEA). THIS IS A GOVERNMENT INSTITUTION

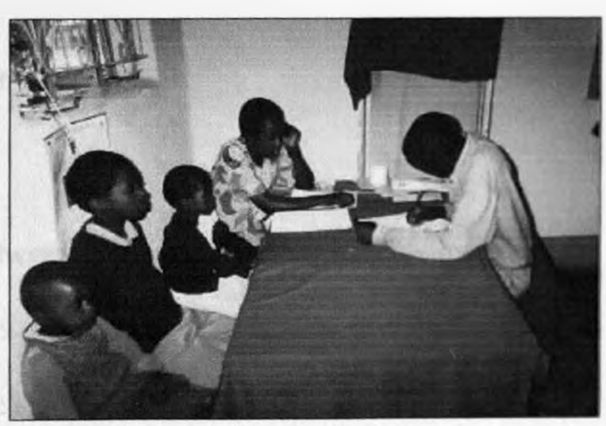


PLATE 3.3 – FIELD ASSISTANTS FILL IN QUESTIONNAIRES AT MURINDUKO DISPENSARY

PLATE 3.4 AND INSET – LABORATORY TECHNICIANS PREPARE AND EXAMINE BLOOD FILMS AT MURINDUKO DISPENSARY

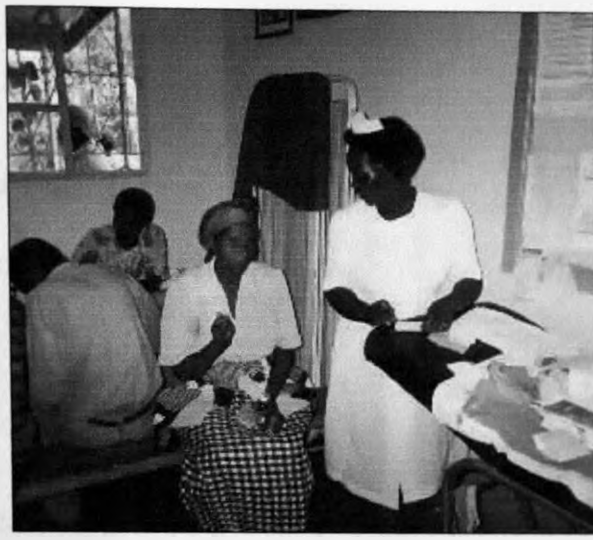


PLATE 3.5 – PATIENTS RECEIVE MEDICAL TREATMENT AT MURINDUKO DISPENSARY

PLATE 3.6 – FIELD ASSISTANTS FILL IN QUESTIONNAIRES AT A CHURCH BUILDING IN MBUI NJERU VILLAGE

PLATE 3.7 – LABORATORY TECHNICIANS PREPARE BLOOD FILMS AT A CHURCH BUILDING IN MBUI NJERU VILLAGE

3.7 Inclusion and Exclusion Criteria

The inclusion criteria were the following:

- Households within selected villages in Mwea;
- For malaria prevalence, all children 0 to 9 years of age in selected households;
- Those who accepted to participate in the study.

The exclusion criteria were the following:

- Households outside selected villages;
- For malaria prevalence, everyone above nine years of age;
- Those who did not accept to participate in the study.

3.8 Data Analysis

Quantitative data was entered into a computer, cleaned by running frequencies, and analysed using statistical software (SPSS™). Missing data was obtained from the questionnaires, which were well coded for easy retrieval. Bivariate rather than multivariate analyses were carried out, given the relatively small sample size. The tests performed included the t-test for continuous variables and the Chi-square test for categorical variables. Thematic analysis was undertaken for qualitative data.

3.9 Limitations of the Study

The major limitation of this study is its cross-sectional nature. Some of the limitations of a cross-sectional study could be overcome by undertaking a cohort study.

As with all studies, there exists the possibility that individuals in the selected households may decline to co-operate. To reduce this, the objectives and potential benefits of the study were made clear to the participants. In addition, the selection of field assistants from within the village gave the participants a sense of ownership and allayed suspicion. In order to minimise recall bias, recall of facts was limited to relatively short periods. The use of a random number generator to select the sample of participants significantly reduced any selection bias. In order to reduce interviewer bias, all field assistants were trained and the questionnaire pre-tested.

This being a cross-sectional study, the findings, notably on malaria prevalence cannot be generalised for the following reasons:

- The mosquito population and by extension, transmission of malaria, varies throughout the year and therefore collecting data at one point in time may not be truly representative of the real picture;
- Variations in socio-demographic characteristics among villages (such as immunity) may influence malaria prevalence;
- In a cross-sectional study such as this one, one cannot make conclusive inferences as far as cause and effect are concerned. However, potential correlations could be brought to light and hypotheses generated.

3.10 Ethical Considerations

The proposal for this study was presented for approval to the ethical committees of the DOMC of the Ministry of Health (Kenya) and the Department of Community Health of the University of Nairobi (Kenya) respectively. Thereafter, informed consent by subjects and community leaders was obtained before commencement of the study. In addition, the following were brought to the attention of the subjects:

- Possible benefits, risks, and inconveniences of the study and side effects of procedures therein;
- Confidentiality of information gathered would be maintained;
- Treatment would be provided for subjects who had cough and fungal skin diseases and for those who were positive for malaria parasites (Plate 3.5);
- Subjects reserved the right to decline to participate in the study.

4. Results

4.1 Socio-Demographic Characteristics of the Study Population

During the Stakeholders' Consultative Workshop, the participants were asked what organization they represented, what their organization did in Mwea, where in Mwea their organization worked, with whom their organization collaborated, and the greatest challenge/problem encountered by their organization.

Among the organisations represented were agricultural and horticultural organisations, churches, co-operative societies, health institutions, self-help groups, the Ministries of Agriculture and Home Affairs, and the National Irrigation Board. Their activities were varied, and included management, research, provision of health services, marketing of farm produce, health education, spiritual nourishment, rice production and marketing, irrigation policy formulation, and agricultural extension services. Their site of activity was Mwea. The participants highlighted a number of challenges. Among these were management of water for irrigation, health problems notably malaria, transport for delivery of produce to markets, drunkenness, ignorance, lack of funds for various projects, and misuse of funds.

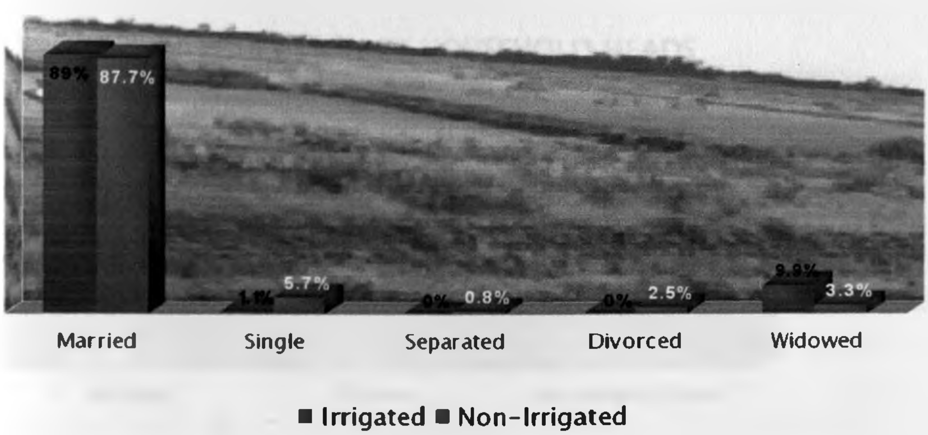
Demographic findings from the Community Diagnosis revealed that the majority (99.5%) of the respondents were the household heads while the remainder were their spouses *(n=212)*. The average age in years of the household head was 43.6±14.6 (95% CI 41.5–45.7), indicative of a wide variation, with the youngest being 20 years and the oldest being 86 years. There were no significant differences in average age of household head between the irrigated and non-irrigated villages. The average age for irrigated villages was 44.3 years and 43.0 years for non-irrigated villages ($t=0.607$, $df=178$ and $p>0.05$).

The average number of people per household was 5.13±1.7 (95% CI 4.9–5.4), with a minimum of two people and a maximum of eleven people. No significant difference in the number of people per household was demonstrated between the irrigated and non-irrigated villages ($t=-1.79$, $df=199$, $p>0.05$). The average number of people per household in irrigated villages was five while that in the non-irrigated villages stood at 5.4 people.

Comparison of the sex of the household heads revealed that 85.9% were males and 14.1% were females and there were no significant differences in this respect between the irrigated and non-irrigated villages ($\chi^2=0.76$, $df=1$, $p>0.05$).

The majority of respondents (88.3%) were married. Despite this, there were significant differences in marital status between the irrigated and non-irrigated villages, with most of the single, separated, or divorced respondents being in the non-irrigated villages (Figure 4.1).

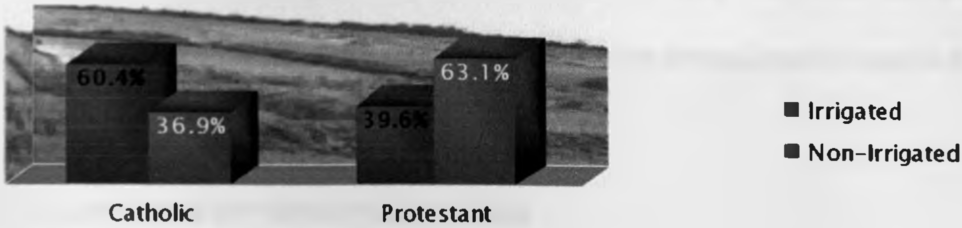
FIGURE 4.1 – MARITAL STATUS OF HOUSEHOLD HEADS



$n=213$, $\chi^2=9.71$, $df=4$, $p<0.05$

Slightly more than half (53.1%) of the respondents were Protestants, while 46.9% were Catholics. Comparison of religion between the irrigated and non-irrigated villages showed significant differences with the irrigated villages being predominantly Catholic and the non-irrigated villages being predominantly Protestant (Figure 4.2).

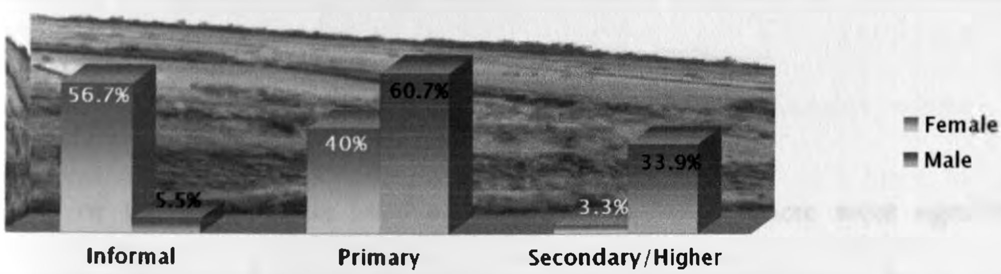
FIGURE 4.2 – RELIGION OF HOUSEHOLD HEADS



n=213, χ^2=11.61, df=1, p<0.05

The majority of household heads (57.7%) had received primary education. Only about 30% had received secondary education or higher. There were no significant differences in level of education of household head between the irrigated and non-irrigated villages (χ^2=3.29, df=2, p>0.05). However there were significant differences in level of education of household head between the sexes, with most females having attained primary education or lower (Figure 4.3).

FIGURE 4.3 – LEVEL OF EDUCATION OF HOUSEHOLD HEADS



n=213, χ^2=63.34, df=2, p=0.00

Slightly more than half (51.6%) of the household heads were farmers, while 22.1% were unemployed or retired. A minority were students. The rest, in roughly equal proportions, were either self-employed or in salaried employment. There were significant differences in occupation of household head between the irrigated and non-irrigated villages. Most of the household heads in the irrigated villages were farmers or were in salaried employment while most of the self-employed or unemployed/retired household heads was from the non-irrigated villages. About 2% of those in the irrigated villages were unemployed (Figure 4.4).

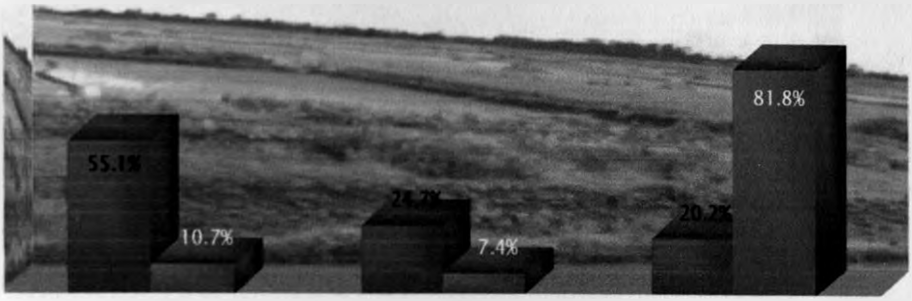
FIGURE 4.4 - OCCUPATION OF HOUSEHOLD HEADS

n=213, χ^2=45.04, df=3, p=0.00

The vast majority of respondents (99.5%) owned the houses they lived in. The remaining 0.5% lived in rented houses *(n=211)*.

Most (55.7%) of the respondents lived in temporary houses. There were significant differences in type of house between the irrigated and non-irrigated villages. Most of the respondents in the non-irrigated villages lived in temporary structures while most of those in the irrigated villages lived in permanent structures (Figure 4.5).

FIGURE 4.5 - TYPE OF HOUSE



n=210, χ2=79.40, df=2, p=0.00

4.1.1 Village Demographics

Ciagi-ini

The approximate population of Ciagi-ini was 1681. Of these, about 47% were females and 53% were males. This is reflected in the overall sex ratio of 1:1.12, females to males. A large proportion of the population (65.8%) were above 15 years of age. Males headed approximately 77% of the households. Figures 4.6 and 4.7 show, respectively, the age distribution and sex distribution within the various age groups. There were a higher proportion of males except within the 'under-five' age group.

Cattle were the predominant type of livestock, making up about 76% of all the livestock. Cattle routinely graze in common land but the situation is rapidly changing as 'jua kali' (informal) rice farmers keep taking up every available piece of land.

FIGURE 4.6 - AGE DISTRIBUTION [Ciagi-ini]

n=1681

FIGURE 4.7 - SEX DISTRIBUTION WITHIN AGE GROUPS [Ciagi-ini]

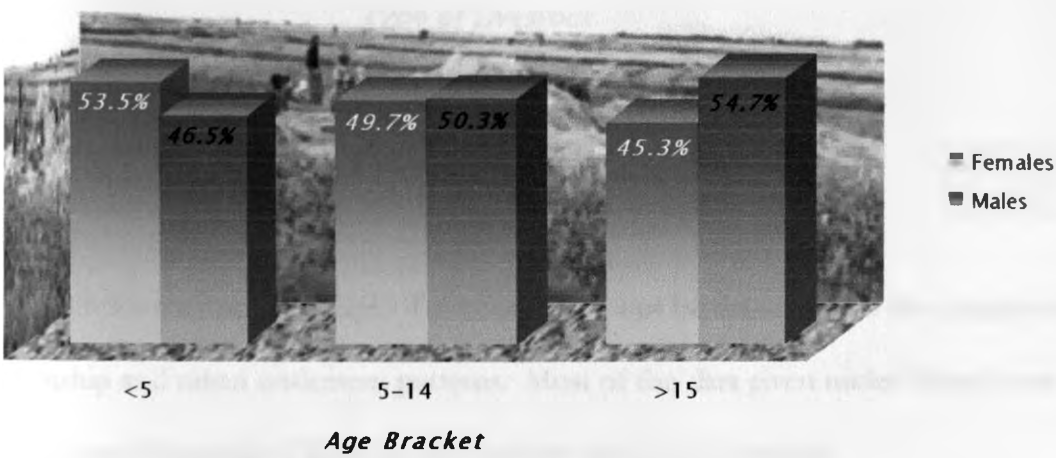


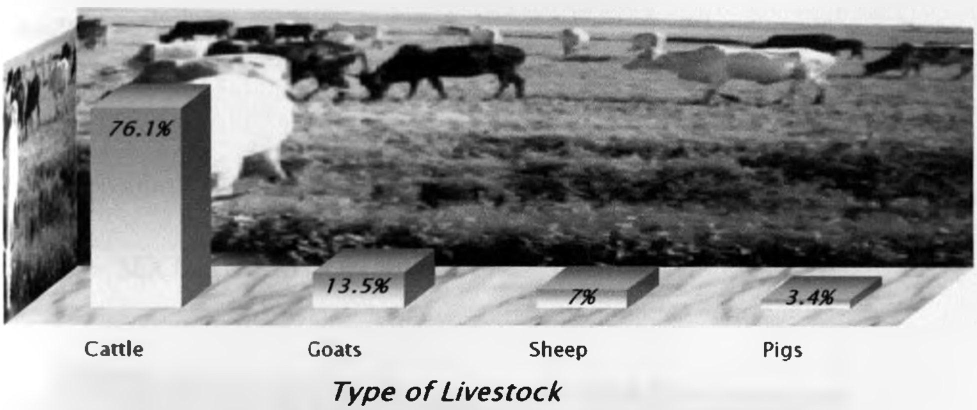
TABLE 4.1 - SEX RATIO [Ciagi-ini]

Age in Years	*Ratio (F:M)*
<5	1:0.87
5-14	1:1.01
>15	1:1.21
Overall	1:1.2

TABLE 4.2 - HOUSEHOLD HEADSHIP [Ciagi-ini]

Male headed households	76.4%
Female headed households	23.6%
n=237	

FIGURE 4.8 - LIVESTOCK POPULATION AND DISTRIBUTION BY TYPE [Ciagi-ini]



n=883

Kagio

Social and resource maps for Kagio Township could not be drawn due to the complexity of the township and urban settlement patterns. Most of the data given under 'Kagio' was that collected from Kiamachiri Village on the outskirts of Kagio Township.

The approximate population of Kagio was 787. Of these, about 46% were females and 54% were males. This is reflected in the overall sex ratio of 1:1.16, females to males. A large proportion of the population (64.2%) were above 15 years of age. Males headed approximately 70% of the households. Figures 4.9 and 4.10 show, respectively, the age distribution and sex distribution within the various age groups. There were a higher proportion of males within the age groups.

Goats were the predominant type of livestock, making up about 57% of all the livestock.

FIGURE 4.9 - AGE DISTRIBUTION [Kagio]

n=787

FIGURE 4.10 - SEX DISTRIBUTION WITHIN AGE GROUPS [Kagio]

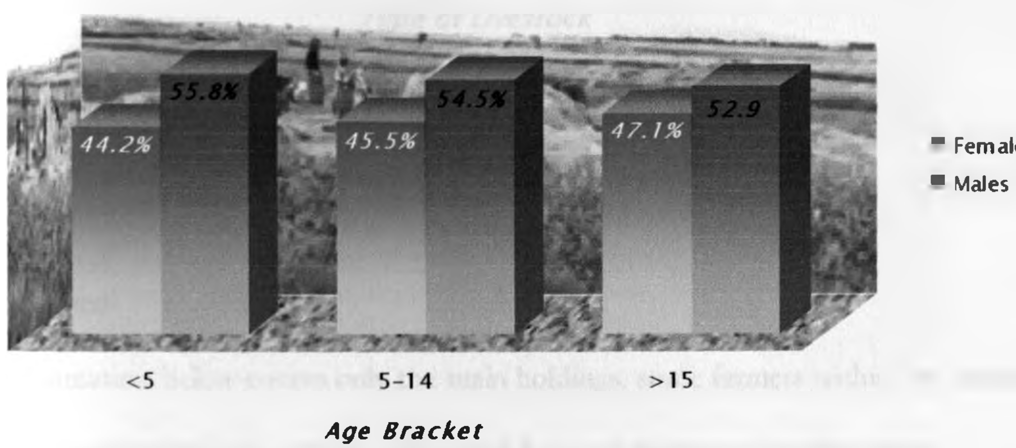


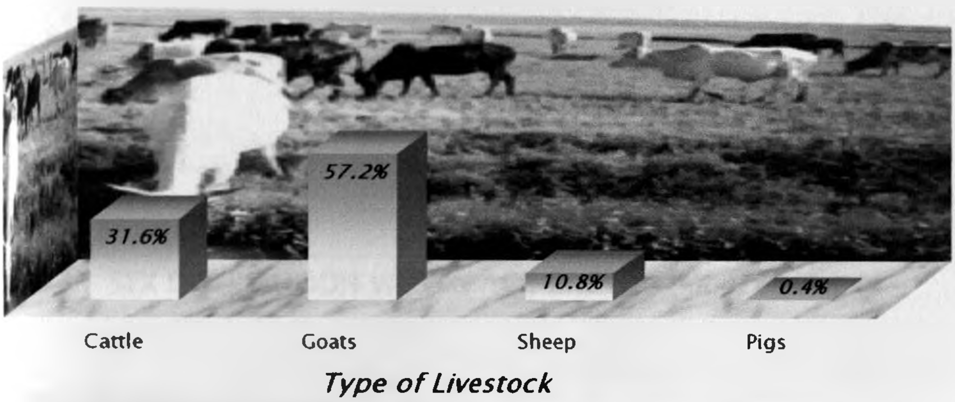
TABLE 4.3 - SEX RATIO [Kagio]

Age in Years	*Ratio (F:M)*
<5	1:1.26
5-14	1:1.20
>15	1:1.12
Overall	1:1.16

TABLE 4.4 – HOUSEHOLD HEADSHIP [Kagio]

Male headed households	69.7%
Female headed households	30.3%
n=89	

FIGURE 4.11 – LIVESTOCK POPULATION AND DISTRIBUTION BY TYPE [Kagio]



n=697

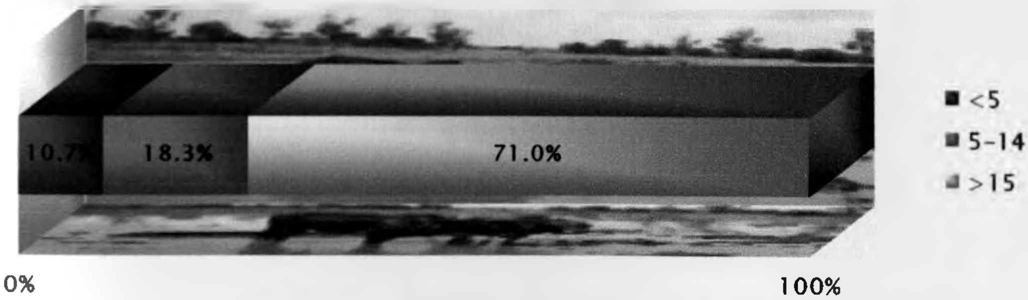
Mbui Njeru

The information below covers only the main holdings, since farmers within the 'extensions' (plots not within the main scheme allocation) keep on migrating to other areas.

The approximate population of Mbui-Njeru was 224. Of these, about 44% were females and 56% were males. This is reflected in the overall sex ratio of 1:1.29, females to males. A large proportion of the population (71%) were above 15 years of age. Males headed approximately 77% of the households. Figures 4.12 and 4.13 show, respectively, the age distribution and sex distribution within the various age groups. There was a higher proportion of males within the age groups, with a distinctly large disparity within the '5-14' age bracket.

Cattle were the predominant type of livestock, making up about 70% of all the livestock.

FIGURE 4.12 – AGE DISTRIBUTION [Mbui Njeru]



n=224

FIGURE 4.13 – SEX DISTRIBUTION WITHIN AGE GROUPS [Mbui Njeru]

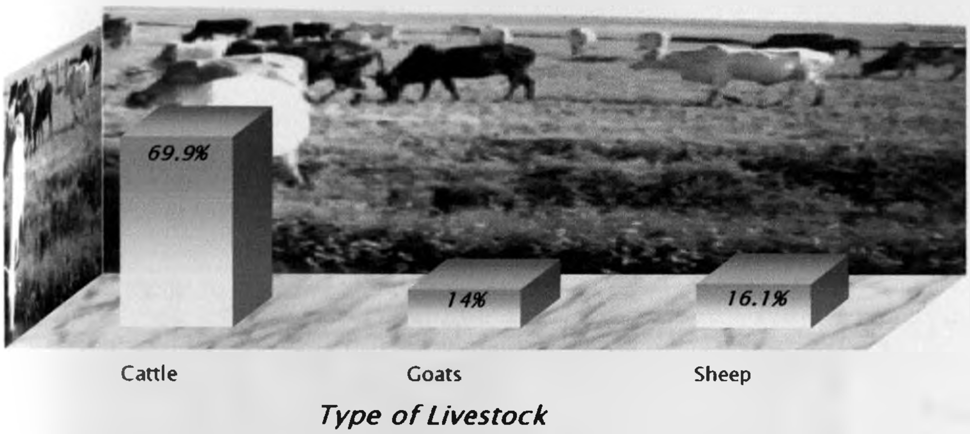
TABLE 4.5 – SEX RATIO [Mbui Njeru]

Age in Years	*Ratio (F:M)*
<5	1:1.18
5-14	1:2.64
14-49	1:1.17
49+	1:1.22
Overall	1:1.29

TABLE 4.6 - HOUSEHOLD HEADSHIP [Mbui Njeru]

Male headed households	76.9%
Female headed households	23.1%
n=52	

FIGURE 4.14 - LIVESTOCK POPULATION AND DISTRIBUTION BY TYPE [Mbui Njeru]



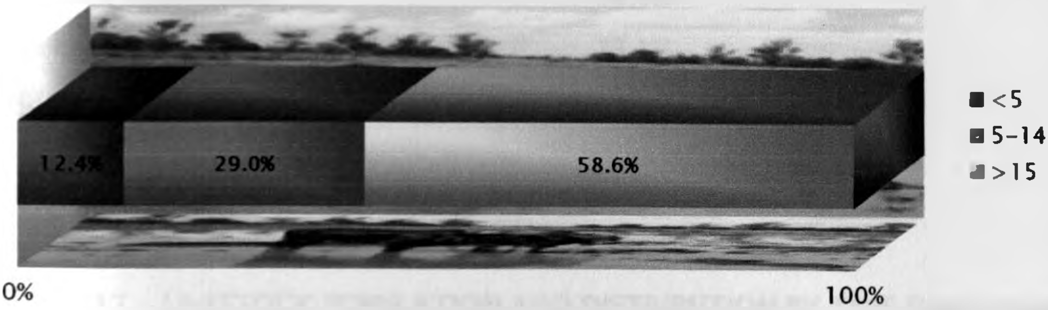
n=93

Murinduko

The approximate population of Murinduko was 971. Of these, about 47% were females and 53% were males. This is reflected in the overall sex ratio of 1:1.13, females to males. A large proportion of the population (58.6%) were above 15 years of age. Males headed approximately 77% of the households. Figures 4.15 and 4.16 show, respectively, the age distribution and sex distribution within the various age groups. There were a higher proportion of males within the age groups, except within the 'over-15' age bracket.

Goats were the predominant type of livestock, making up about 81% of all the livestock.

FIGURE 4.15 – AGE DISTRIBUTION [Murinduko]



n=971

FIGURE 4.16 – SEX DISTRIBUTION WITHIN AGE GROUPS [Murinduko]

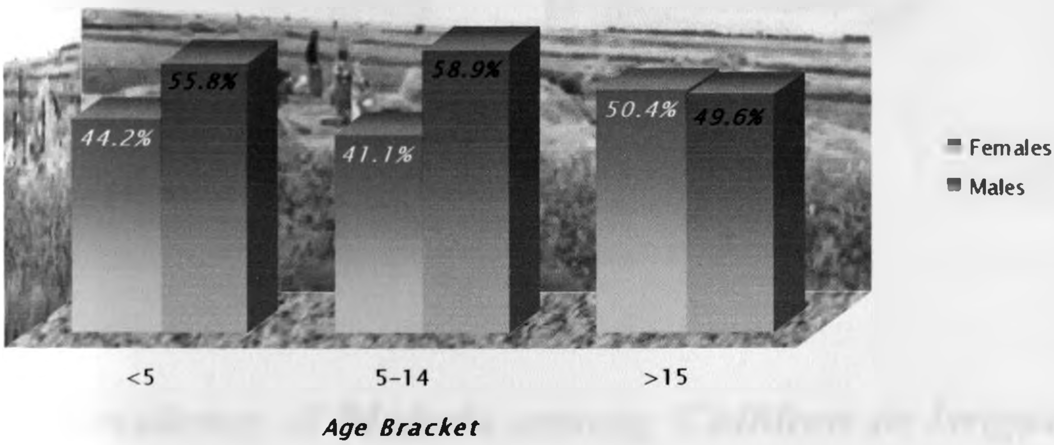


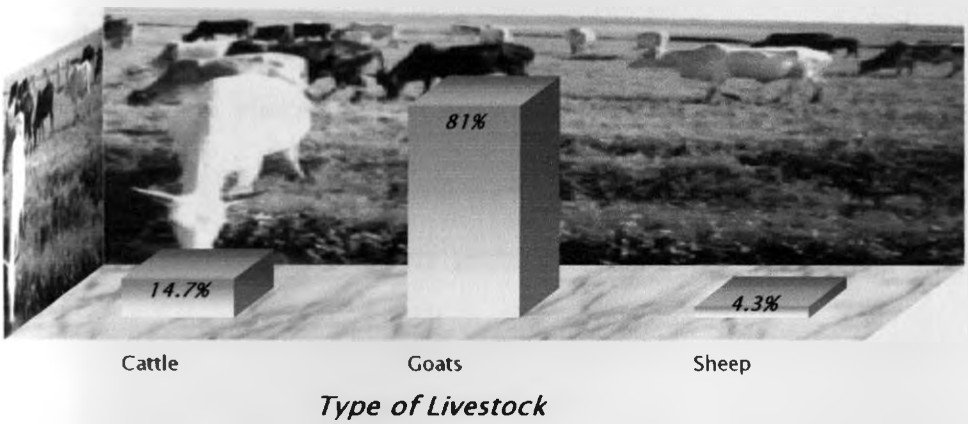
TABLE 4.7 – SEX RATIO [Murinduko]

Age in Years	*Ratio (F:M)*
<5	1:1.26
5-14	1:1.43
>15	1:0.98
Overall	1:1.13

TABLE 4.8 – HOUSEHOLD HEADSHIP [Murinduko]

Male headed households	76.9%
Female headed households	23.1%
n=242	

FIGURE 4.17 – LIVESTOCK POPULATION AND DISTRIBUTION BY TYPE [Murinduko]



n=441

4.2 Prevalence of Malaria among Children in Irrigated and Non-Irrigated Villages

The health related problems listed during the Stakeholders' Consultative Workshop are presented in Table 4.9 below. There were 19 participants at this session.

TABLE 4.9 – HEALTH RELATED PROBLEMS AS PERCEIVED BY THE STAKEHOLDERS

PROBLEM	TALLY
Lack of clean water	6
Malaria	4

Alcoholism	3
Poor nutrition	2
HIV/AIDS	1
Poor sewage facilities	1
Poverty	1
Ignorance	1
n=19	

This table reveals that malaria was the major health related problem after lack of clean water. The participants were asked to consider each problem in turn and to give what in their opinion were their causes, effects, and the strategies that could be employed to solve them. The responses pertaining to malaria only are considered in *4.4* and *5.4*.

In addition, according to the Stakeholders' problem identification chart (Plate 3.1), malaria was thought to be more prevalent within the irrigated villages.

Participatory Rural Appraisal

The PRA captured a picture of what the respondents regarded as major health problems and their relative magnitude. For the purposes of the PRA, the respondents were grouped according to gender.

In Ciagi-ini, the respondents cited the following health problems. The major health problems cited by women included malaria, typhoid, bilharzia, pneumonia, common cold, and sexually transmitted infections notably syphilis, gonorrhoea, and HIV/AIDS.

Ranked in order of frequency, malaria came first followed by typhoid and pneumonia.

The men on the other hand, mentioned malaria, typhoid, bilharzia, dental problems, and amoebiasis as major health problems but not in any order.

Seasonal Variation and Fifteen-Year Trend for Malaria in Ciagi-ini

- *Women:* Malaria in Ciagi-ini village occurred during all seasons throughout the year. It affected people of all ages i.e. men, women, and children. The respondents reported that malaria had been more prevalent within the last 3 years. The villagers felt that since the mobile clinical services ceased some years ago the incidence of malaria had risen. They also reported that in the past, the NIB would spray rice fields with insecticides but currently the services were no longer available. In addition, they said that the Kenyan economy was in bad shape and could not support many of the services that were available in the past.
- *Men:* The period of peak incidence was reported as being from December to March. This coincided with the flooding of the rice fields and more so, with the growth of the rice plants themselves, which provided ideal breeding grounds for mosquitoes.

  In the preceding 15 years, malaria had generally been on the increase though the perceived rate of increase had reduced during the last 6 years. The participants attributed this general increase to the following:
  - Increase in resistance to first-line anti-malarial drugs;
  - Lack of interest in health education concerning malaria control and prevention on the part of villagers;
  - Services initially provided by the NIB, such as spraying of the canals to control mosquitoes and their larvae were no longer available. This was because the NIB was no longer accepted within the Scheme, and was therefore not active there.

The following were the health problems reported by the respondents in Kagio.

The women listed a large number of major health problems. These were malaria, typhoid, pneumonia, HIV/AIDS, skin diseases, tetanus, meningitis, sexually transmitted infections such as gonorrhoea and syphilis, female genital mutilation, and abortions.

They ranked the four most important health problems in order as malaria, typhoid, HIV/AIDS, and abortions.

The men cited three major health problems. These were malaria, HIV/AIDS, and typhoid.

Seasonal Variation and Fifteen-Year Trend for Malaria in Kagio

- *Women:* Since 1988, malaria cases have been on the rise. In 1988, one would have been cured by taking chloroquine. In 1992, malaria was moderately prevalent but was increasingly becoming more resistant to drugs and was more prevalent than in the 1980s.
- *Men:* The peak incidence was identified as being from March to May and from September to December. This coincided with the planting of rice and the flooding of the rice fields. The 'jua kali' (informal) rice growers planted rice twice a year, which meant that the land was flooded twice a year, coincident with the peaks of malaria prevalence. In the preceding 15 years, malaria had generally been on the increase. The participants attributed this general increase to the following:
    - Increase in resistance to first-line anti-malarial drugs;
    - Increase in the number of informal rice farmers, therefore increased flooding (more stagnant water);
    - Poor sewage system (made worse by a growing population), leading to stagnation of water;
    - Poverty, therefore inability to obtain adequate medical care;
    - Lack of health education and malaria control by the Government.

In Mbui Njeru, the following were the health problems reported by the respondents. The women cited, and ranked in order of importance, the common health problems as being malaria, typhoid, bilharzia, cholera, stress/depression, backaches, coughs/colds, HIV/AIDS/STDs, eye infections, giardiasis, amoebiasis, and tuberculosis.

The men also ranked the major health problems in order of importance as malaria, typhoid, and bilharzia.

Seasonal Variation and Fifteen-Year Trend for Malaria in Mbui Njeru

- *Women:* Malaria prevalence had been constant since irrigation water to the rice fields had been flowing for more than ten years. Moreover, the rice fields were adjacent to their village.
- *Men:* The peak incidence was identified as being from September to January, approximately four months after the flooding of the rice fields when growth of the rice plants themselves provided ideal breeding grounds (bushes) for mosquitoes.

  In the preceding 15 years, malaria had generally been on the increase due to the following reasons:
  - An increase in the number of rice fields, since many younger people were starting their own 'jua-kali' (informal) rice fields outside those originally demarcated by the NIB;
  - With the exit of the NIB, people planted rice twice a year and this meant more water and therefore breeding grounds were present for longer each year.

The respondents in Murinduko cited a large number of health problems. These were: malaria, typhoid, abdominal pains, chest pains, pneumonia, whooping cough (at 6 months), low back pain, eye problems, diabetes, stomach ache, colds, intestinal worms, skin infections (especially among children), and 'pain in the bones'.

The more common health problems were ranked as follows starting with the one they perceived as most serious: malaria, typhoid, and pneumonia.

Seasonal Variation and Fifteen-Year Trend for Malaria in Murinduko

The respondents reported that in the preceding 15 years, there had been a gradual increase in malaria prevalence. All age groups were affected. However, those below five years of age developed severe infections.

Community Diagnosis

During Community Diagnosis, nearly all (96%) of the respondents cited mosquitoes as the cause of malaria (Table 4.10).

TABLE 4.10 - CAUSES OF MALARIA

Causes	*Proportion*
Mosquitoes	96.0%
Wetness/Flooding	2.5%
Cold/Climate Change	1.0%
Don't Know	0.5%
n=202	

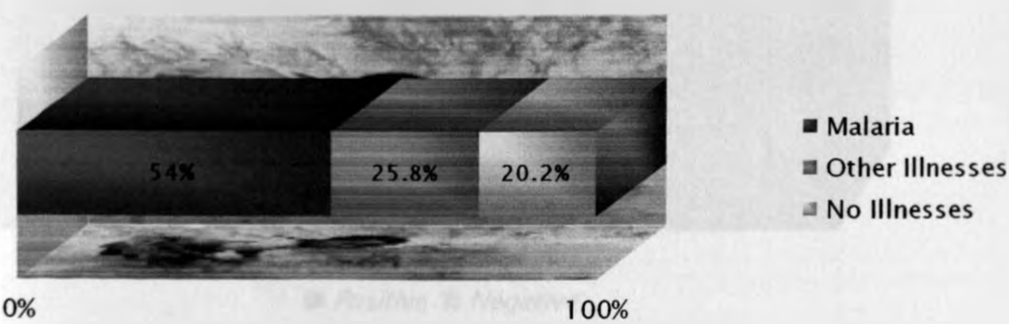
Most of the respondents (71.2%) cited the use of bed nets as a malaria-prevention method (Table 4.11).

TABLE 4.11 - MALARIA-PREVENTION METHODS

Method	*Proportion*
Nets	71.2%
Anti-Malarial Drugs	6.1%
Clearing Bushes	4.0%
Go to Hospital	3.0%
Cover All Openings	3.0%
Boil Drinking Water	2.5%
Cow Dung	1.5%
Wear Warm Clothes	1.5%
Drain Stagnant Water	1.0%
Spray Insecticides	0.5%
Herbal Medicine	0.5%
Don't Know	5.1%
n=198	

Respondents were required to report any illness among family members in the preceding two weeks. Of all the respondents, 54% reported malaria while 25.8% reported other illnesses. The rest reported no illness at all.

FIGURE 4.18 - REPORTED ILLNESS



n=213

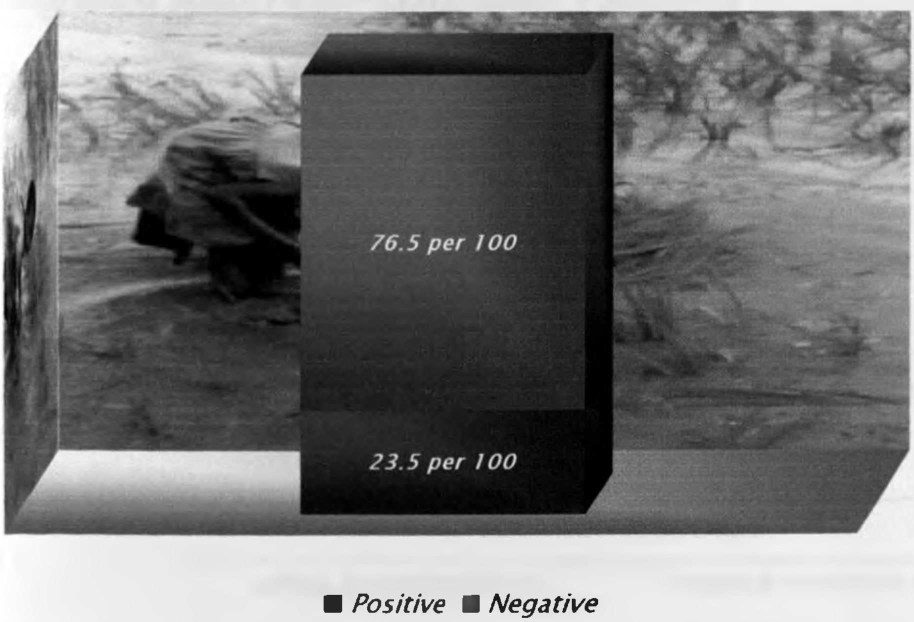
Malaria Prevalence Survey

Of all the respondents who took part in the Malaria Prevalence Survey, 32.9% were from Ciagi-ini, 27.7% from Kagio, 9.9% from Mbui Njeru, and 29.6% from Murinduko *(n=213)*. 46.5% of the children examined were females and the rest were males.

Data from the blood films obtained during the Malaria Prevalence Survey showed that the overall prevalence of malaria for the four villages stood at 23.5 per 100 (Figure 4.19). These results are based on parasitological rather than clinical evidence. However, 47.4% of the 213 children examined were reported as having had fever in the preceding three days. Only 41.3% of the children were reported as having had additional symptoms. Most had headaches, abdominal pains, diarrhoea, and shivering in addition to fever.

Most (98%) of the positive slides were due to infection by *Plasmodium falciparum*. The remaining 2% was due to infection by *Plasmodium malariae.*

FIGURE 4.19 - OVERALL MALARIA PREVALENCE



Within the individual villages, the malaria prevalence varied as shown in Figure 4.20.

FIGURE 4.20 - MALARIA PREVALENCE IN EACH VILLAGE

4.3 Comparison and Contrast of Malaria Prevalence in Irrigated and Non-Irrigated Villages

The Stakeholders gave the problem density, by vote, within the irrigated and non-irrigated areas. There were 17 participants at this session. According to them, there was a higher prevalence of malaria in the irrigated than in the non-irrigated areas (Table 4.12).

TABLE 4.12 - PROBLEM DENSITY COMPARISON BETWEEN IRRIGATED AND NON-IRRIGATED AREAS

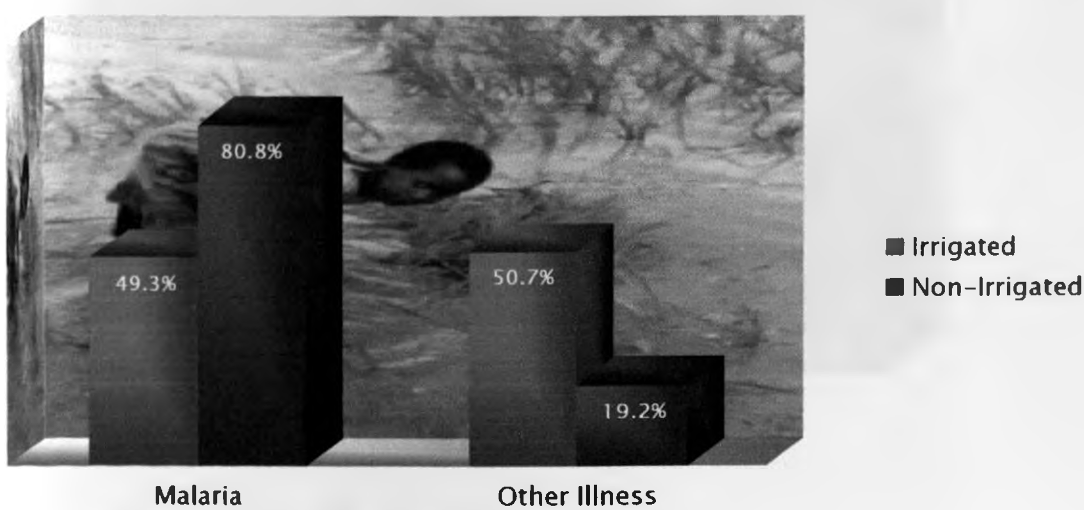
PROBLEM	LOCATION AND TALLY	
	WITHIN SCHEME (IRRIGATED)	OUTSIDE SCHEME (NON-IRRIGATED)
Lack of clean water	13	4
Malaria	14	3
Alcoholism	14	3

Poor nutrition	6	11
HIV/AIDS	7	10
Sewage	6	11
Poverty	0	17
Ignorance	6	11

Findings from the Community Diagnosis regarding reported illness revealed that 80.2% of the respondents within irrigated villages and 83.5% of those within non-irrigated villages reported that a member of their household had been ill in the preceding two weeks. However, there were no significant differences between the irrigated and non-irrigated villages in this respect.

However, when a comparison was made between the irrigated and non-irrigated villages with regard to type of illness reported, there were significant differences. Most of the people who reported malaria were in the non-irrigated villages (Figure 4.21).

FIGURE 4.21 - TYPE OF ILLNESS REPORTED IN IRRIGATED AND NON-IRRIGATED VILLAGES



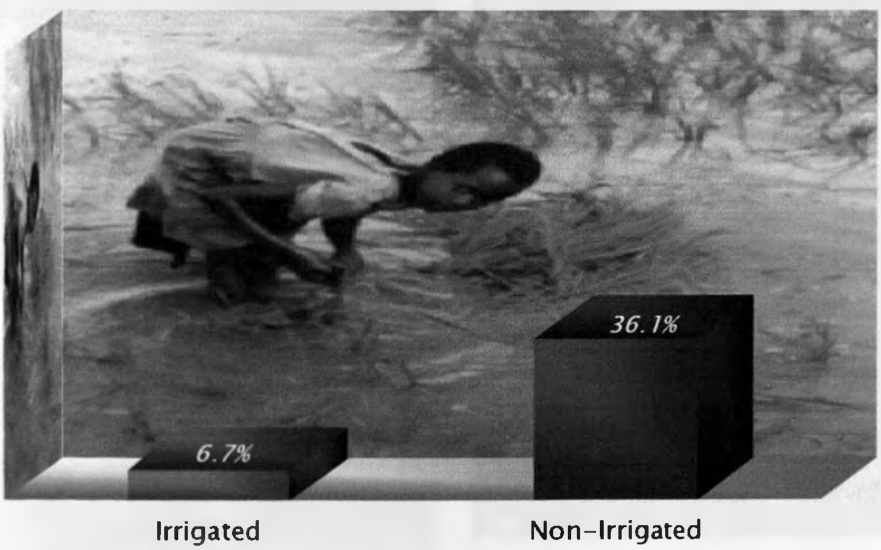
n=170, χ^2=18.76, df=1, p=0.00

The overall response rate for the Malaria Prevalence Survey was 74.5%. Within the irrigated and non-irrigated villages, it was 81% and 70% respectively.

There were no significant differences in age of subject between the irrigated and non-irrigated villages ($t=-1.099$, $df=204$, $p>0.05$, and 95% CI −1.19-0.34). The mean age in years of subjects in the irrigated villages was 3.87 ± 2.62, while that of subjects in the non-irrigated villages was 4.30 ± 2.88.

Based on parasitological evidence from the Malaria Prevalence Survey, malaria prevalence was compared between villages within and outside the Scheme. There were significant differences in malaria prevalence between the irrigated and non-irrigated villages. Within the irrigated villages, the prevalence was 6.7 per 100, while in the non-irrigated villages it was 36.1 per 100 (Figure 4.22).

FIGURE 4.22 – MALARIA PREVALENCE IN IRRIGATED AND NON-IRRIGATED VILLAGES



$n=213$, $\chi^2=25.20$, $df=1$, $p=0.00$

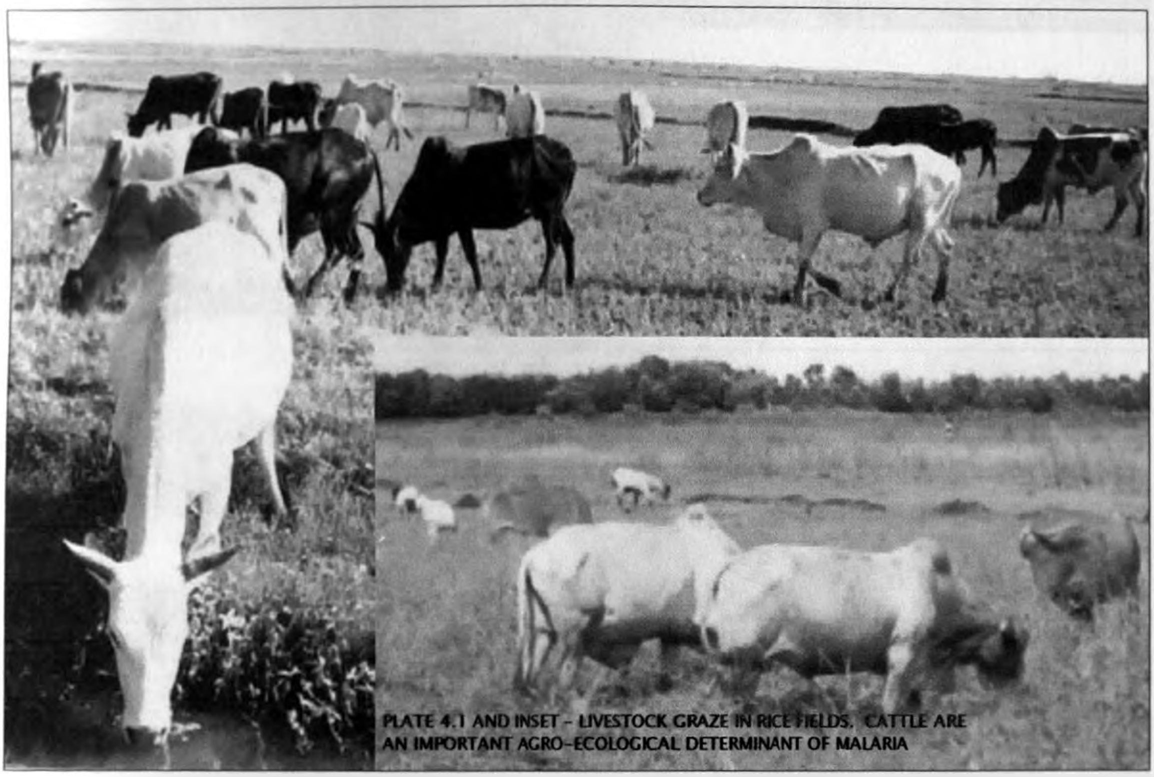


PLATE 4.1 AND INSET – LIVESTOCK GRAZE IN RICE FIELDS. CATTLE ARE AN IMPORTANT AGRO-ECOLOGICAL DETERMINANT OF MALARIA

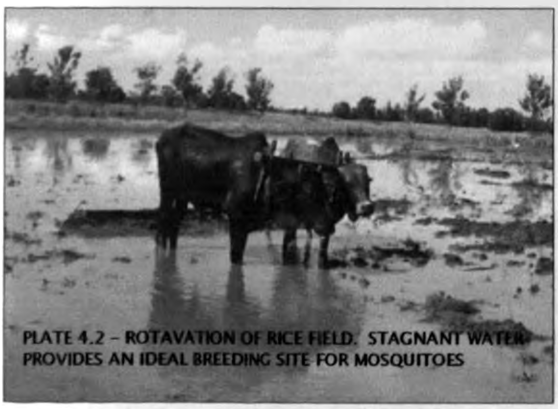


PLATE 4.2 – ROTAVATION OF RICE FIELD. STAGNANT WATER PROVIDES AN IDEAL BREEDING SITE FOR MOSQUITOES

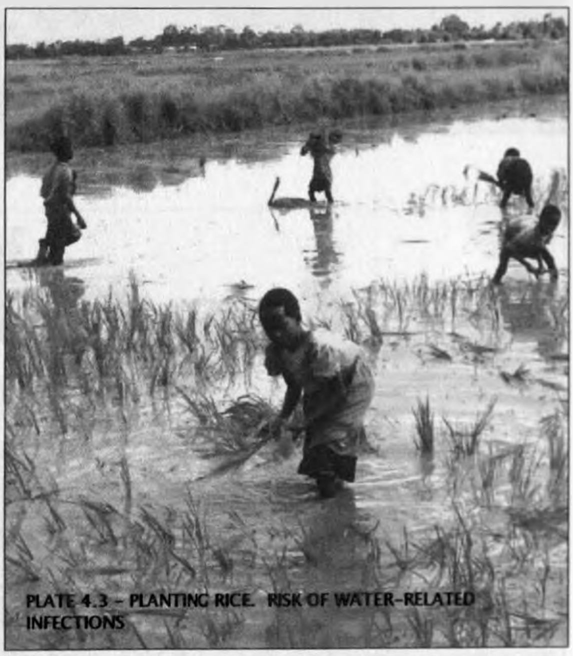


PLATE 4.3 – PLANTING RICE. RISK OF WATER-RELATED INFECTIONS

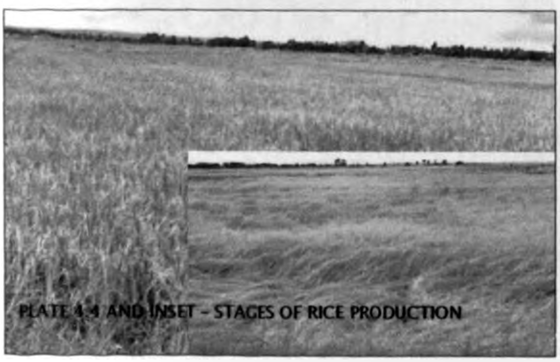


PLATE 4.4 AND INSET – STAGES OF RICE PRODUCTION

PLATE 4.5 AND INSET - HARVESTING RICE

PLATE 4.6 AND INSET - RICE FIELDS AFTER HARVESTING

PLATE 4.7 - CHILDREN LEAVE SCHOOL AT THE END OF THE DAY. MALARIA CAN LEAD TO SCHOOL ABSENTEEISM.

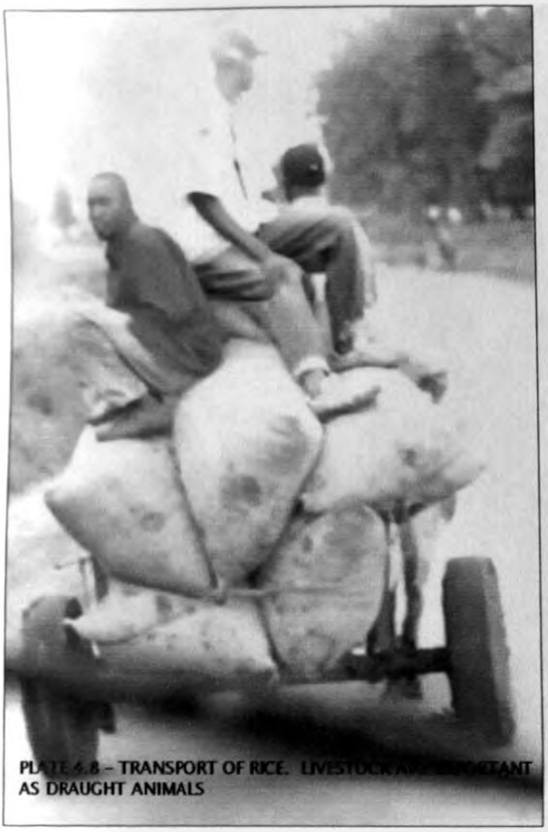


PLATE 4.8 – TRANSPORT OF RICE. LIVESTOCK ARE IMPORTANT AS DRAUGHT ANIMALS

PLATE 4.9 – RICE MILL AT WANG'URU (MWEA)

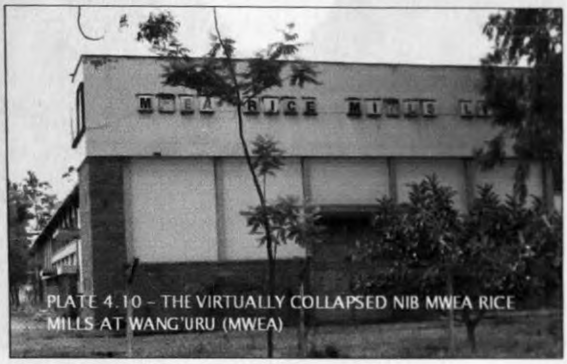


PLATE 4.10 – THE VIRTUALLY COLLAPSED NIB MWEA RICE MILLS AT WANG'URU (MWEA)

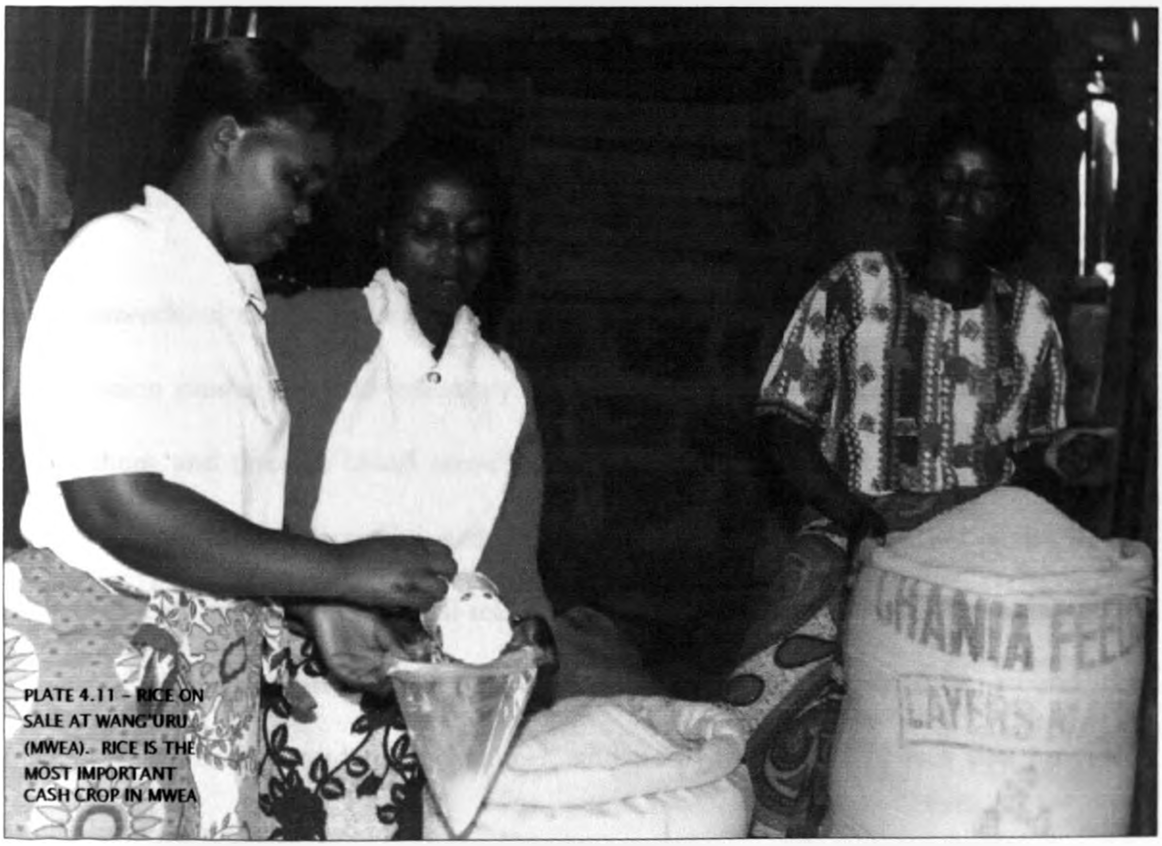


PLATE 4.11 – RICE ON SALE AT WANG'URU (MWEA). RICE IS THE MOST IMPORTANT CASH CROP IN MWEA

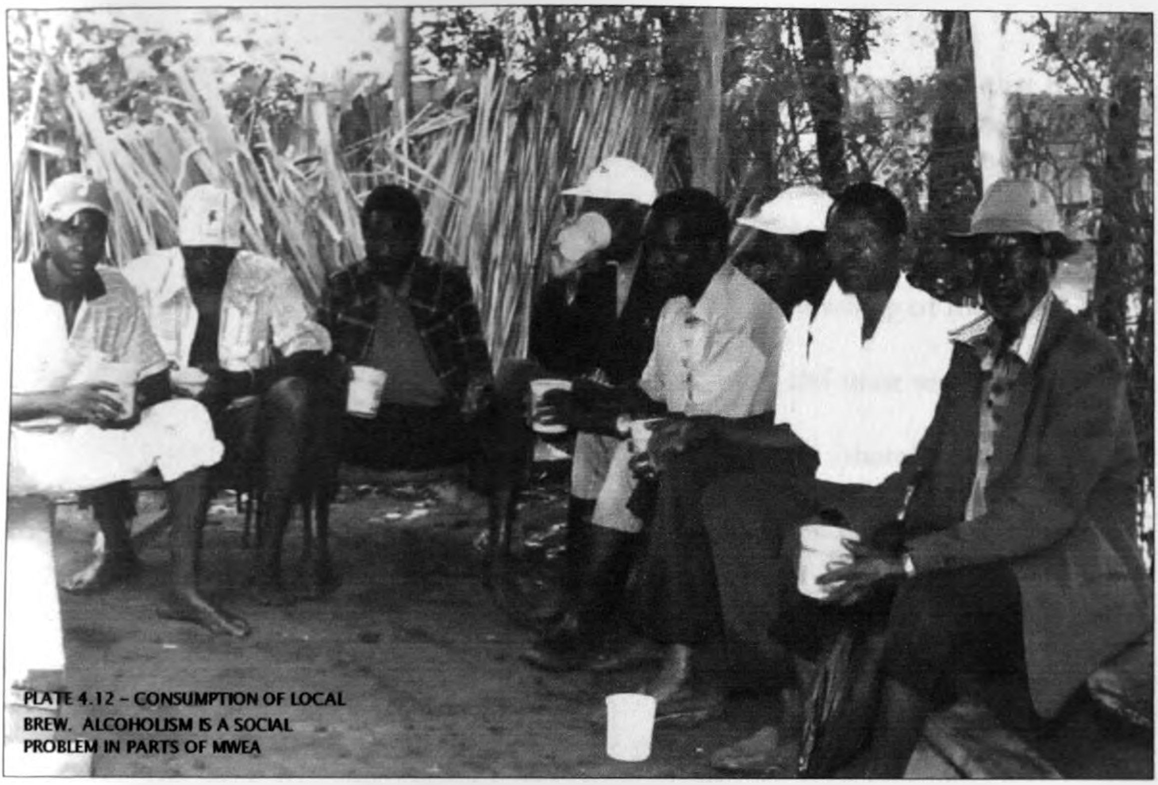


PLATE 4.12 – CONSUMPTION OF LOCAL BREW. ALCOHOLISM IS A SOCIAL PROBLEM IN PARTS OF MWEA

4.4 Possible Risk Factors For Malaria Among The Study Population

The human-related causes/risk factors for malaria as listed by the Stakeholders included poor nutrition causing lowered immunity, infected needles, infection of unborn babies by their mothers, and through blood transfusion. The water-related factors cited were poor sanitation, stagnant water, activities such as rice growing, and too much water in rice fields. The participants cited environmental-related factors as the following: bushes, congestion leading to infection from one person to another, garbage, empty cans around the homesteads, *plasmodia* spread by mosquitoes, and poorly ventilated houses that provided resting places for mosquitoes.

Other than malaria, most of the other causes of problems cited by the participants were social in nature and included alcoholism, ignorance, and idleness.

The risk factors given by participants during the PRA were varied. They noted that those below five years of age, those at the extremes of age, and those who 'do not have strength' (possibly those with malnutrition) were particularly susceptible to severe infections. Stagnant water was another risk factor that was made worse by the flooding of the rice fields (especially by the informal rice farmers who do this twice a year) and poor sewage disposal systems. Other risk factors cited were garbage (littering), poverty (therefore inability to obtain adequate medical care), lack of health education and malaria control by government, lack of mosquito nets, the 'cold atmosphere of the Scheme', and a lack of interest in health education concerning malaria control and prevention on the part of villagers.

During Community Diagnosis, the participants cited the following risk factors for malaria: high mosquito density (most cited this), untidiness, litter, damp environment, flooding, cold climate, climatic change, flowering season, drinking dirty water, and eating rice (only one cited this).

Malaria Prevalence Survey

In terms of knowledge as regards malaria prevention and control, there were no significant differences between irrigated and non-irrigated villages.

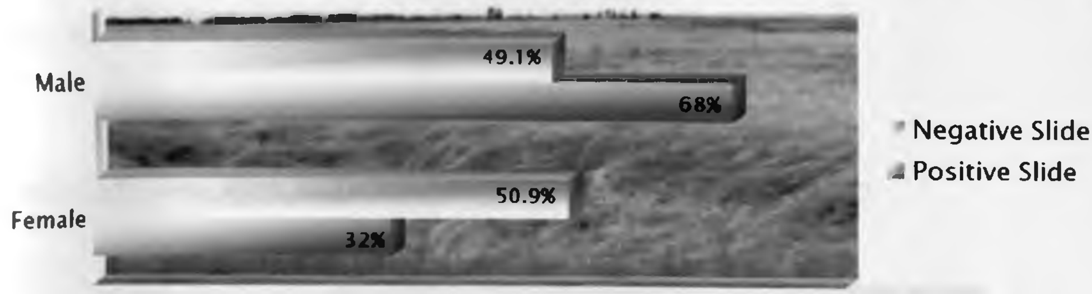
Malaria was significantly related to irrigation, being more prevalent in the non-irrigated villages than in the irrigated villages (Figures 4.21 and 4.22).

Significantly more children who had fever in the preceding three days had a positive blood slide (χ^2=6.45, df=1, p<0.05).

Age of subject was not significantly related to a positive blood slide.

Sex of subject was significantly related to a positive blood slide with more males than females being positive for malaria (Figure 4.23).

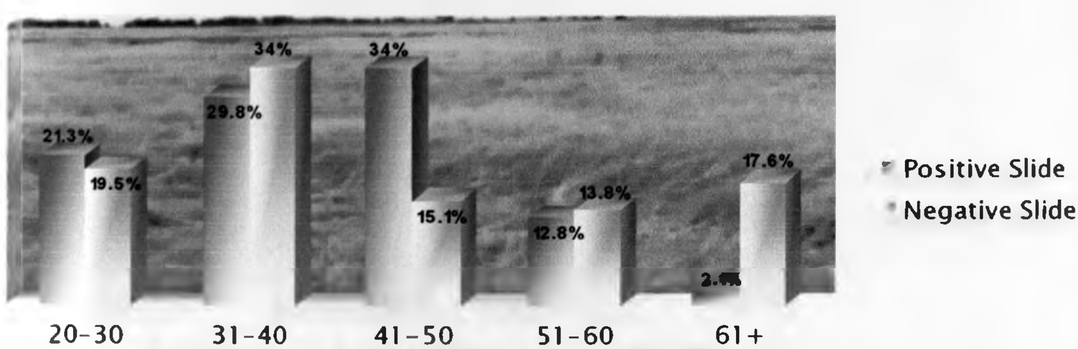
FIGURE 4.23 - MALARIA AND SEX OF SUBJECT



n=213, χ^2=5.51, df=1, p<0.05

Age of household head was significantly related to a positive blood slide. Those household heads that were in the 41-50 year age group formed the bulk of those whose children had a positive blood slide. Those in the 31-40 year age group had the highest number of children with a negative blood slide. Generally, however, household heads below 50 years of age (who made up 72.3% of household heads) had a higher proportion (85.1%) of children with a positive blood slide (Figure 4.24).

FIGURE 4.24 - MALARIA AND AGE OF HOUSEHOLD HEAD



n=206, χ^2=13.16, df=4, p<0.05

Neither level of education nor sex of the household head was significantly related to a positive blood slide.

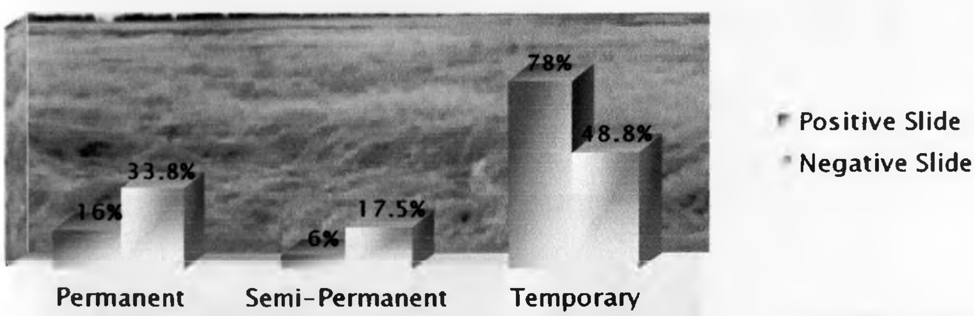
Occupation of the household head was significantly related to a positive blood slide, in that those household heads that were unemployed/retired had the highest proportion of children with a positive blood slide (Figure 4.25).

FIGURE 4.25 - MALARIA AND OCCUPATION OF HOUSEHOLD HEAD

n=213, χ^2=20.23, df=3, p=0.00

There was a significant relationship between type of house and malaria prevalence. The majority (78%) of children with a positive blood slide lived in temporary structures (Figure 4.26).

FIGURE 4.26 - MALARIA AND TYPE OF HOUSE



n=210, χ^2=13.33, df=2, p<0.05

Utilization of bed nets in the household was varied as presented in Table 4.13 below. Use of bed nets was reported in about 81% of all households in the sample.

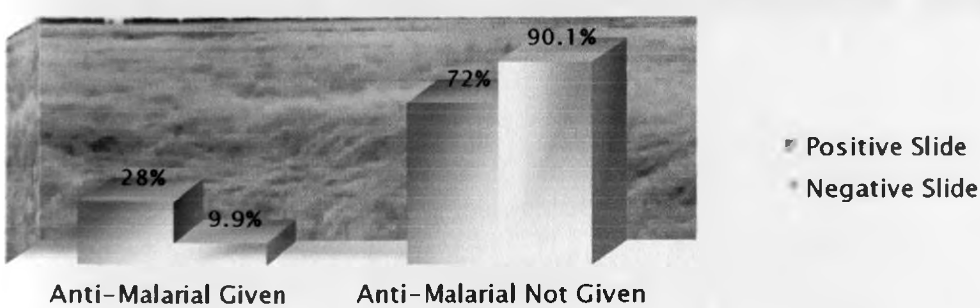
TABLE 4.13 - UTILIZATION OF BED NETS

User	*Proportion*
All Members	75.0%
Children Only	9.0%
Parents and Small Children	4.5%
Parents Only	11.5%
n=172	

There was no significant relationship between use of bed nets and a positive blood slide. However, there were significant differences in reported use of bed nets between irrigated and non-irrigated villages (χ^2=20.43, df=4, p=0.00). More respondents in the irrigated villages reported that all household members used bed nets as compared to the non-irrigated villages. More respondents in the non-irrigated villages reported that they did not use bed nets at all.

There was a significant relationship between the use of anti-malarial drugs in the preceding three days and a positive blood slide. Most of the children who had used an anti-malarial drug had a negative blood slide (Figure 4.27). Of those who knew the name of the anti-malarial drug given, most reported that it was an SP drug.

FIGURE 4.27 - MALARIA AND USE OF ANTI-MALARIAL DRUGS



n=212, χ^2=10.33, df=1, p<0.05

There was no significant difference in administration of anti-malarial drugs between irrigated and non-irrigated villages. There was also no significant relationship between administration of anti-malarial drugs and other factors such as level of education, occupation, age, religion, or sex of household head, or type of house.

The average number of *Anopheles arabiensis* mosquitoes in a house was significantly related to irrigation and to a positive blood slide (χ^2=213.00, df=3, p=0.00 and χ^2=47.62, df=3, p=0.00 respectively). There was also a significant difference in the average number of *Anopheles arabiensis* mosquitoes in a house between irrigated and non-irrigated villages (t=23.58, df=211, p=0.00, and 95% CI 0.76-0.90). The mean number of *Anopheles arabiensis* mosquitoes in a house in the irrigated villages was 2.04±0.17, while that in the non-irrigated villages was 1.20±0.31. Houses that had a lower average number of *Anopheles arabiensis* mosquitoes had a higher proportion of positive blood slides.

Distance between cowshed and living quarters was significantly different between irrigated and non-irrigated villages, being shorter in the former than in the latter (Mann-Whitney U=1133.50, Z=−2.14, p<0.05). The average distance in metres was 8.8±5.84 (95% CI 7.74–9.94). The shortest distance was one metre and the longest 25 metres.

The average number of sleeping rooms per house was 2.2±0.99 (95% CI 2.05–2.32). The lowest number was one room and the highest was six rooms. Only 16% of the houses had screened eaves in the master bedroom (Room 1).

Only 1.9% of the houses had screened windows in the master bedroom (Room 1). The rest had unscreened windows.

5. Discussion

5.0 General

The Mwea community has been subjected to institutional advisory services and technology transfer instructions delivered from centralised hierarchical authorities such as the NIB and government ministries. These have largely been top-down approaches without due emphasis on participatory problem solving. Generally, the government-supported institutional framework has weakened in recent years with regard to agricultural extension services among others, and the community has had to endure this breakdown. Access to social services has become harder due to government reforms that have resulted in cost-sharing measures regardless of the economic status of many resource-poor communities.

From the Stakeholders Workshop, it was evident that the key areas were health, agriculture, and social services. It was clear that a number of institutions had a stake in Mwea. This is advantageous since these institutions cover a wide range of specialities from which expertise could be drawn and from which a broad-based framework could be formulated to resolve some, if not all, of the issues raised at this workshop. The different sectors involved make intersectional collaboration feasible, and more so since they were all contributors and participants at the workshop. For intervention strategies, co-operation between the different sectors is essential.

The information clearly revealed that within the Scheme, malaria, alcoholism, and lack of clean water were the predominant problems. Outside the Scheme (non-irrigated area), the predominant problems were poor nutrition, HIV/AIDS, lack of sewerage systems, poverty, and ignorance. Poverty was not perceived as a problem at all within the irrigated area. Mbui Njeru village stood out in terms of perceived health problems. Malaria, alcoholism, and lack of clean water were dominant. Lack of sewerage facilities was mentioned in Ciagi-ini village.

In Murinduko village, which was materially the poorest, alcoholism, was not mentioned among the chief problems; probably the people were more concerned with survival strategies. HIV/AIDS was cited as being particularly prevalent in Kagio, which is considered relatively wealthy. Its location along the Kutus-Sagana road makes it a transit point for merchants travelling to and from the horticulturally and agriculturally rich surrounding area. Their proceeds from the sale of produce means that they could easily afford a range of items on offer for sale at Kagio, casual sex being one of them. It is not too difficult then to see why HIV/AIDS would be perceived as a problem here.

Many participants linked poor nutrition, malaria incidence and prevalence, and low productivity to idleness. Lack of education was cited as one of the effects of malaria. This would probably be due to absence from school of children suffering from malaria.

The effects of malaria as given by the Stakeholders included deaths from anaemia, abortions, miscarriage, brain damage, and low birth weight. 'Economic strains' resulted from payment of medical bills and transport to and from the health facility. Because of this, family resources were drained leading to poverty. Other effects cited were decreased productivity due to lowered immunity and a reduced workforce, time wastage while seeking treatment, malnutrition in children, an unhealthy community due to prolonged illness, lack of education, and permanent impairment after treatment especially after using quinine.

This analysis confirmed the people's knowledge of their environment. This calls for a holistic approach to improving health and enhancing development in the area. Empowerment of the people through job creation by the Government, NGOs, or private sector in addition to providing an enabling environment for entrepreneurship by the people themselves would be a step in the right direction.

5.1 Socio-Demographic Characteristics of the Study Population

Demographic factors revealed that in general there were slightly more males than females in all the villages. In Mbui Njeru, this disparity was more pronounced.

From several perspectives women find themselves in subsidiary positions to men and are socially, culturally, and economically dependent on them. They are mostly barred from making decisions, have restricted access to and control over resources, are restricted in their mobility, and are often at risk of violence from male relatives.[54] Figure 4.3 demonstrates the disparity in level of education between male and female household heads, and quite possibly, by extension, males and females. Sons are perceived to have economic, social, or religious value. Individual and societal beliefs about and attitudes towards appropriate gender specific roles, and the choices of individuals and households on the basis of these factors, mean that women are underprivileged with regard to educational opportunities, health and health care. Globally, gender related differences in health status have led to an unbalanced sex ratio for the past 100 years, which is declining further. Gender discrimination at each stage of the female life cycle contributes to this inequity. Sex selective abortions, neglect of girl children, reproductive mortality, and poor access to health care for girls and women have all been cited as reasons for this difference. In some regions of the world, this has led to gender based health disparities among the population aged less than 5 years. This neglect may take the form of poor nutrition, lack of preventive care (specifically immunisation), and delays in seeking health care for disease. Early marriage and pregnancy, anaemia, sexual violence, and poor educational opportunities all contribute to ill health among female adolescents. By their nature, reproductive health hazards are borne by women alone. Adolescents, especially young women, are disproportionately affected by HIV infection worldwide; adolescence is also a time when vulnerabilities to injury, including motor vehicle crashes and suicide, as well as substance abuse, rise. Maternal deaths—most commonly from haemorrhage, sepsis, and eclampsia—continue to exact a high toll; unsafe abortions also contribute to deaths from haemorrhage and sepsis. Home deliveries by unskilled attendants, a scantiness of knowledge of intrapartum danger signs, and poor transport mechanisms to and lack of appropriate care at health facilities all contribute to this burden. Decisions about seeking care in such emergencies are made largely by the husband or the elder members of his family. The combination of perceived ill health and lack of support mechanisms contributes to a poor quality of life.[64]

The majority of the households were male headed. This is to be expected in the paternalistic society that Kenya is. The few female-headed households could be attributed to factors such as single motherhood, bereavement, separation, and divorce.

Another clear finding is that the villages within the irrigation scheme had a higher proportion of cattle than those outside the Scheme. Possession of cattle is a sign of wealth. In addition, the NIB enforced a restriction on the rearing of cattle within the Scheme. With the departure of the NIB, this restriction is no longer observed. Cattle are used as draught animals (for rotavation of rice fields among other applications) and their presence within the labour-intensive irrigated villages is beneficial and expected, and therefore consistent with the findings.

Most of the respondents were the household heads themselves. This is advantageous in that the household head was more likely to have most if not all of the facts required. The information gathered was therefore bound to be more accurate and comprehensive than if it were gathered from one who was not the household head. Since there were no significant differences in age of household head between the irrigated and non-irrigated villages, unbiased comparison of attributes likely to be influenced by age of household head were therefore possible.

In addition, the number of people per household was not significantly different between the irrigated and non-irrigated villages. Again, this would permit unbiased comparison between the two populations on factors likely to be influenced by household size. Given that the average number of sleeping rooms per house was two and the average number of people per household was five, congestion would not be a problem with two to three people per room. Though there were more male-headed households, there were no significant differences in sex of household head between the irrigated and non-irrigated villages. Even though the vast majority of household heads were married, there were significant differences in marital status of household head between the irrigated and non-irrigated villages. The implications of this are discussed under *5.4*.

5.2 Prevalence of Malaria among Children in Irrigated and Non-Irrigated Villages

Qualitative data exposed a broad array of health problems. In all data collection exercises except the Stakeholders' Consultative Workshop (which ranked malaria second), malaria was ranked first; it topped the list of health problems in all the four study villages. The other problems (in order of importance) included typhoid, pneumonia, common colds and amoebiasis. Other significant diseases included low back pain, ophthalmic diseases, and dental problems. Some reported that children under five years of age were more adversely affected. This is consistent with scientific knowledge that this age group suffers more severe forms of disease mainly due to sub-optimal immunity.

The fifteen-year trend inquiry for malaria in all the villages showed a general increase. This perception could have been influenced by an increase in resistance to anti-malarial drugs and increased awareness of the disease in terms of its various manifestations. One cannot rule out some amount of information bias, given that the *raison d'etre* of the project was malaria research and that the quantitative data on prevalence showed that just under a quarter of the population were infected. It is human nature to exaggerate the magnitude of problems with a view to receiving urgent remedial support. Nevertheless, most of those who reported illness in the preceding two weeks reported suffering from malaria. This is an indication of the importance of malaria and that it is perceived to be quite widespread. In addition, more than 90% of the respondents were conversant with at least one malaria prevention method. Quantitative data showed the overall prevalence of malaria in the four villages to be 23.5 per 100. This is indicative of a generally mesoendemic situation (moderate transmission). That most infections were due to *Plasmodium falciparum* is consistent with other findings in Kenya. This species is the cause of the most severe form of malaria and this only underscores the importance of malaria, despite the lower prevalence in Mwea as compared to the Western and Coastal regions of Kenya. It is worth noting that the Malaria Prevalence Survey was carried out during the rainy season, a time associated with flooding of rice fields. This also was the period identified by participants during the PRA as recording peak prevalence of malaria. Different weather conditions between the villages are thus unlikely to influence the findings.

5.3 Comparison and Contrast of Malaria Prevalence in Irrigated and Non-Irrigated Villages

Community Diagnosis generated wide-ranging quantitative household data on health and the environment. A comparison of results from quantitative and qualitative sources showed a high degree of uniformity, meaning that most of the findings confirmed rather than contradicted each other. However, the Malaria Prevalence Survey results somewhat contradict the qualitative data obtained from the irrigated villages. A case in point was Mbui Njeru, where the qualitative data ranked malaria first whereas the quantitative data from the

Malaria Prevalence Survey showed no positive cases. In addition, according to the Stakeholders (Plate 3.1 and Table 4.12), malaria was thought to be more prevalent within the irrigated villages. This was in stark contrast to what was revealed by the Community Diagnosis and Malaria Prevalence Survey, which clearly showed the opposite. This may suggest that their perception of malaria may deviate from what health professionals would know to be malaria. In several communities in Kenya, the term malaria is used variously to describe fever, coughs and colds, and aching limbs. Because of this, any illness that presented with these symptoms would be referred to as malaria. On the other hand, this cross-sectional survey revealed the malaria situation only at one point in time. A study that is more extensive is required in order to provide a wider picture of malaria in Mwea throughout the year.

The results of the comparative analysis revealed that malaria prevalence was significantly related to irrigation ($\chi^2=25.20$, df=1, p=0.00), being higher within the non-irrigated villages than within the irrigated ones (Figures 4.16, 4.17, and 4.18). This is not an entirely unusual finding given that the same general picture has been observed elsewhere where similar comparative studies have been conducted.[28,39,45,46] This may also be partly because the population within the Scheme may have received more health education with regard to malaria prevention given that irrigation is perceived to pose a greater risk for malaria. In addition, it may be because at a certain level of income, a family is able to adopt malaria control measures.[38] Therefore, a community with relatively higher economic development, such as that within the Scheme, would be associated with greater use of anti-malarial measures, and within a community, wealthy individuals would be more likely to use such measures.[39,40] Other authors also suggest that many communities near irrigation schemes benefit from the greater wealth created by these schemes. Consequently, irrigation communities often have greater use of bed nets, better access to improved healthcare and receive fewer infective bites compared to those outside such development schemes.[28] This is consistent with the finding in this study that although there was no significant relationship between use of bed nets and a positive blood slide, there was a significant difference in use of bed nets between irrigated and non-irrigated villages with more respondents in the former reporting that all household members used bed nets as compared to the latter. More respondents in the non-irrigated villages reported that they did not use bed nets at all (Table 4.13 and related text). This suggests that malaria control interventions might be skewed. However, there was no significant difference in knowledge as regards malaria prevention and control between the two populations.

The results of the Malaria Prevalence Survey are consistent with the findings of recent studies conducted in Africa on malaria prevalence.[28,39,45,46]

According to a review article by Ijumba and Lindsay,[28] increased numbers of vectors following irrigation could lead to increased malaria in areas of unstable transmission, where people have little or no immunity to malaria parasites, such as the African highlands and desert fringes.[28] However, for most of sub-Saharan Africa, where malaria is stable, the introduction of crop irrigation has little impact on malaria transmission.[28] Indeed, there is growing evidence that for many sites there is less malaria in irrigated communities than surrounding areas. The explanation for this finding is still unresolved. Some cases can be attributed to displacement of the endophilic and anthropophilic malaria vector *Anopheles funestus* by the more exophilic and zoophilic *Anopheles arabiensis* with lower vectorial capacity. *Anopheles arabiensis* thrives better than *Anopheles funestus* in rice fields. From the results on livestock populations, it can be seen that the villages in the irrigated areas have a predominance of cattle. This makes this explanation plausible since cattle are a preferred host for the zoophilic *Anopheles arabiensis*. In addition, blood meals from mosquitoes collected from households within the irrigated villages were found to be composed almost entirely of bovine blood. In the villages within the non-irrigated areas, there is a predominance of goats, which are not a preferred host for *Anopheles arabiensis*. This would mean that the endophilic and anthropophilic malaria vector *Anopheles funestus* would not be displaced as much by *Anopheles arabiensis* given the relatively lower cattle population in these areas. This might also explain the lower average number of *Anopheles arabiensis* in houses within the non-irrigated villages.

5.4 Possible Risk Factors For Malaria Among The Study Population

During the Stakeholders' Consultative Workshop, the participants suggested various strategies for the prevention and control of malaria. These were based on what they considered risk factors for malaria. These strategies included drainage of stagnant water, clearance of bushes around the home, use of mosquito nets, spraying of flooded rice paddies with insecticides, seeking proper medical treatment when sick, and good nutrition to avoid lowered immunity. Some recommended that certain items be made available to them at an affordable price if not free of charge from the government. Such items included mosquito nets, drugs, 'malaria oil' for killing larvae in stagnant water, insecticides to control mosquitoes, and vaccination. However, it was explained to them that a malaria vaccine was not yet available. In addition, they mentioned better management of floodwater in the rice fields, health education and community training in matters of public health preferably by PHTs, filling up of water ponds, and proper disposal of garbage as other strategies.

During the PRA, the participants cited various social and other problems such as alcoholism, poverty, ignorance, and HIV/AIDS.

They highlighted some concerns touching on gender issues as follows:

- Heavy workload for women, with the exception of Murinduko where men and women shared work fairly. This was explained by the fact that the people of Murinduko were extremely poor and to ensure survival, everybody had to work.
- Men controlled most of the resources despite the fact that they did less work (except in Murinduko).
- In all areas, men controlled most of the benefits including rice, livestock, and money and this applied to all areas, including Murinduko. This discouraged those who worked but had little power over the proceeds from their work.

These concerns are important since they may affect the way resources are allocated, which may in turn have a direct impact on the prevalence of diseases such as malaria. This is because if money were needed for medical emergencies, it would not be readily available to the women who in most cases were directly concerned with the welfare of the children. In addition, alcoholism, poverty, and ignorance, which were cited by participants during the PRA, could be considered as risk factors for malaria and other illnesses. Clearly, if one were ignorant of the prevention measures that should be undertaken in order to reduce the risk of contracting malaria, one would not allocate any resources towards instituting them. Alcoholism would negatively affect the health and well-being of the family since most of the money that would otherwise be used in improving the standard of living (which includes but is not limited to proper medical care/prevention of diseases) would be wasted on alcohol. Poverty is a more complex problem to deal with but needless to say, it precludes allocation of resources to 'less pressing' items which ironically may just as well include disease-prevention measures. In this scenario, only immediate needs that touch on basic survival (food, clothing, shelter) are given priority.

As discussed in section *5.3* above, malaria prevalence was significantly related to irrigation, being higher within the non-irrigated villages than within the irrigated ones.

Sex of household head was neither significantly related to irrigation nor to a positive blood slide.

There were significant differences in marital status of household head between the irrigated and non-irrigated villages, with more single, separated, or divorced household heads being in the non-irrigated villages. All the single or separated household heads were female. In addition, all the divorced or separated, and most of the single household heads lived in temporary houses, were unemployed or retired, and had attained only primary education. Each of these variables may be considered a proxy of socio-economic status. The institution of malaria-prevention strategies or indeed even the very knowledge of the said strategies would be unlikely wholly or in part because of economic challenge and therefore the probability of contracting malaria in these households would be relatively high. Marital strife probably resulting from alcoholism besides disagreement over the allocation of money generated from the sale of rice within the irrigated villages may lead to separation. In most cases, given the paternalistic nature of Kenyan society, women would be forced to move out. This might explain the differences in marital status of household head between the irrigated and non-irrigated villages, since it is within the non-irrigated villages that one would more easily find 'unallocated' land in which to settle. From the PRA, it was noted that the non-irrigated villages (notably Murinduko) had little in terms of economic activity and a significant proportion of the people from these villages sought employment elsewhere including the irrigated areas. Thus, a good number of the people within the non-irrigated villages would consist of 'immigrants', some almost certainly from the irrigated villages and surrounding areas.

There were significant differences in religion between the irrigated and non-irrigated villages. This in itself is unlikely to be a risk factor for malaria since the main teachings of these two denominations are largely the same and therefore their lifestyles are likely to be similar. That notwithstanding, most of the respondents who were unemployed or retired or lived in temporary houses were protestant. In addition, no protestant among the respondents had college or university education. The vast majority had attained primary education only. These proxies of socio-economic status may explain the differences in malaria prevalence between the two religions. A curious finding was the fact that the level of education of the household head was significantly related to the type of house, with most of those with secondary education or higher living in temporary houses ($\chi^2=18.23$, df=4, p=0.01). Additionally, most of them were from the younger age group (40 years and below) while most of the respondents living in permanent structures were from the older age group (41 years and above). The latter age group comprised many of the original settlers of the Scheme who were allotted the permanent houses that were put up by the NIB and this would explain the unexpected distribution.

Occupation of the household head was significantly related to a positive blood slide, with those who were unemployed or retired being associated with the highest prevalence. This group, owing to their economic limitation, are hypothetically unlikely to institute precautionary or remedial measures against malaria. Moreover, those who were unemployed or retired made up the largest proportion of those who lived in temporary structures, while farmers, most of who lived in permanent structures, had the smallest proportion of positive slides.

Age of subject was not significant in terms of malaria prevalence but as would be expected, fever was significantly related to a positive blood slide. There was a significant difference in malaria prevalence between the sexes. This might be due to differences in lifestyle brought upon by cultural and/or societal norms. Males may be more exposed to mosquito bites because of their generally intrinsic outdoor predisposition.

Age of household head was significantly correlated to a positive blood slide. Those household heads who were under 50 years of age formed the bulk of those who lived in temporary houses. Type of house and occupation of household head were significantly related to a positive blood slide and as alluded to earlier, these are proxies of socio-economic status. Moreover, most of the temporary houses were in the non-irrigated villages and were occupied by the bulk of unemployed or retired household heads. Therefore, the differences in malaria prevalence amid the household head age groups could for the most part be ascribed to these factors.

Use of bed nets was not significantly related to a positive blood slide. However, there were significant differences in reported use of bed nets between the irrigated and non-irrigated villages. More household members utilized bed nets in the irrigated villages than in the non-irrigated villages. Bed nets are an effective precautionary measure against malaria and their more extensive use in the irrigated villages may partly explain the difference in malaria prevalence between the two populations. Worth noting is the fact that the Malaria Prevalence Survey targeted only children below nine years of age, whereas the survey on use of bed nets included all members of the household. Thus, the relationship between utilization of bed nets and a positive blood slide was not significant because it may have been somewhat obscured by this skewed comparison.

The use of anti-malarial drugs in the preceding three days had a protective effect since there were significantly less positive blood slides among those who had used an anti-malarial drug than among those who had not. Additionally, there was no significant difference in administration of these drugs between the two populations and across different levels of education, type of house or occupation, age, religion, or sex of household head. This further strengthens the association since it means that the differences did not merely arise from use of drugs in one population and not the other. It was interesting to note that the anti-malarial drug used in most of the cases was an SP drug. In light of recent reports of increased resistance to this group of drugs, this is a significant observation and only indicates that SP drugs may still be of some benefit and probably should not be disqualified from the malaria course of therapy. The therapeutic efficacy is increased when an SP drug is combined with *artesunate.*

There were a higher average number of mosquitoes in houses within the irrigated villages than in those within the non-irrigated villages. The difference in malaria prevalence could be due to the protective measures (such as bed nets) employed by people within the irrigated villages (Table 4.13 and related text). In addition, displacement of the endophilic and anthropophilic malaria vector *Anopheles funestus* by the more exophilic and zoophilic *Anopheles arabiensis* with lower vectorial capacity may play a part (see *5.3*). Since *Anopheles arabiensis* thrives better than *Anopheles funestus* in rice fields, there would be a higher proportion of the latter in the non-irrigated villages. This would partly explain the higher malaria prevalence in the non-irrigated villages since, being anthropophilic and having a higher vectorial capacity, its preferred host is the human being rather than livestock and it delivers more potentially infective bites. The distance between cowshed and living quarters was shorter in the irrigated villages, thus bringing closer to the home the preferred host (read cattle) for *Anopheles arabiensis* whose numbers would then increase, displacing *Anopheles funestus.* The reverse situation occurs in the non-irrigated villages with largely predictable consequences. Most of the houses in the study villages had unscreened windows and eaves and therefore these variables would not influence the difference in malaria prevalence among the villages and between the irrigated and non-irrigated villages.

6. Conclusions and Recommendations

6.1 Conclusions

1. Malaria prevalence is higher in the non-irrigated villages than in the irrigated ones and therefore the hypothesis that there is no difference in malaria prevalence between the irrigated and non-irrigated villages is rejected.
2. The prevalence of malaria was related to socio-economic status, being higher in the villages with a lower socio-economic status.
3. The prevalence of malaria was related to gender, being higher among males than among females.
4. The use of anti-malarial drugs has a protective effect since there were significantly less positive blood slides among those who had used an anti-malarial drug than among those who had not.
5. There was a higher density of *Anopheles arabiensis* in the irrigated villages than in the non-irrigated villages. The higher number of cattle in the irrigated villages may contribute to this.
6. Malaria is a cause of ill health and contributes to the dwindling of family resources.
7. *Plasmodium falciparum* is the parasite responsible for the majority of malaria cases.
8. Most of the household heads possess knowledge of the causes and prevention of malaria.
9. The sex ratio is generally skewed in favour of males.
10. Several key entities are active in Mwea and can pool resources collectively for the benefit of the residents through intersectional collaboration.
11. Social problems such as poverty and alcoholism exist in Mwea.

6.2 Recommendations

1. Intersectional collaboration is needed in order to reduce the disease burden in Mwea. This is so in light of the fact that the problems listed by the Stakeholders are inter-related and cannot be solved merely by emphasising on one aspect alone. More detailed and ongoing research is vital if lasting solutions are to be found. Research projects should of necessity be participatory at all stages, such as was the case with the ICIPE-IWMI Project and, even more importantly, continuous because of the need for monitoring, evaluation, and sharing of new information between concerned parties. This gives the population concerned a sense of ownership and encourages their commitment to directing their efforts at solving most if not all their problems. Commitment by organs of government and the people of Mwea is necessary since the magnitude of problems, judging solely from the Stakeholders' list, is such that none of the relevant organs can go it alone.
2. It is clear that malaria is not the only problem in Mwea. A wide variety of health and social problems exist. A clear cause and effect relationship must be demonstrated between behaviour/habits and ill health in order to encourage a healthy lifestyle. As more women survive into old age, the role of gender differences among older adults will become more important. Women are more vulnerable because they are likely to be illiterate, unemployed, widowed, and dependent on others. Public policy to address the concerns of women and the girl child will be needed.

   The residents of Mwea need empowerment in terms of acquisition of relevant health education and sound economic and business principles in order to improve their socio-economic status and therefore be able to adopt malaria-prevention measures.[38] In addition, some degree of autonomy from restrictive policies such as those meted out by the NIB for example, is necessary to enable the residents to make relevant and beneficial informed decisions. (These policies have mainly been top-down approaches without due stress on participatory problem solving.) To some extent, this has begun with the formation of more 'home-grown' societies such as the Mwea Rice Growers Marketing (MRGM) Co-operative Society Limited. Such societies are hypothetically better able to meet the needs of the people who form them. In addition, a speedy and amicable solution to the ongoing wrangle between the NIB and the rice farmers should be found. Collaboration between such government organs as the NIB on one hand and the residents of Mwea on the other is vital. Both parties have resources which if put to good use will result in an improvement in several aspects of life in Mwea.

3. Malaria is hypoendemic within the irrigated area and is mesoendemic outside it (Figure 4.22). At village level however, Murinduko shows a hyperendemic picture, Kagio a mesoendemic one and both Ciagi-ini and Mbui Njeru a hypoendemic one. In the villages where malaria is hyperendemic and mesoendemic there should be an emphasis on health education with regard to malaria prevention. These communities should be sensitised on the need for use of bed-nets among other control methods available. The use of anti-malarial drugs in children with fever is worth instituting in malaria-prone areas. In addition, easy access to good healthcare is necessary in order to reduce the morbidity due to malaria. This is a policy issue that the Government is best placed to deal with. In the villages where malaria is hypoendemic, the efforts already being made in respect to malaria prevention and control should be encouraged and supported. This could take the form of reminder campaigns during which new information obtained from research could be shared with the community in order to strengthen their efforts and broaden their choices. In addition, bed nets could be introduced at a subsidised rate in order to improve their rate of use. This cross-sectional survey only revealed the

malaria situation at one point in time. Therefore, study that is more extensive is required in order to provide a wider picture of malaria in Mwea throughout the year.

4. Another aspect that has been studied and that could contribute to malaria control is the role of shops and shopkeepers, given that a number of people with malaria would seek medication from them as a first option. The shopkeepers felt that they needed more information on the use and dosages of the anti-malarial drugs they stocked. They suggested that the best way to disseminate this information was through the radio.[65]
5. The geographical pattern of admissions of malaria patients to hospital has been studied. It was found that admission rates were higher in children with easier access to the hospital. Those living 25 km from the hospital had admission rates that were about one fifth of those for children living within 5 km of the hospital. Those living more than 2.5 km from the nearest road had admission rates that were about half of those for children living within 0.5 km of a road. The study concluded that hospital admission rates for severe malaria are higher in households with better access to a hospital than in households further away.[66] In light of this, the development of infrastructure and medical facilities should be an important government goal as far as malaria control is concerned.
6. The use of epidemiological maps in malaria control is acquiring importance as a means of gaining understanding of how epidemiological variables relate to disease outcome. Recent evidence suggests that the clinical outcomes of infection are determined by the intensity of parasite exposure. Models that relate ecological and climatic features to malaria intensity and improvements in the understanding of the relationships between parasite exposure and disease outcome will hopefully provide a more rational basis for malaria control in the near future.[67] The use of Geographical Information Systems (GIS) in mapping malaria transmission should be encouraged.

7. Since less than 25% of persons suffering from malaria seek formal treatment in most of sub-Saharan Africa, facility-based morbidity statistics are inadequate for monitoring malaria control programmes.[63] An explorative study assessed whether a health centre equipped with a microscope and trained personnel could monitor malaria transmission within its catchment area. The proportion of blood smears positive for malaria parasites was high in children below 36 months of age. There was a tendency for low proportion of blood smears positive for malaria in children whose mothers reported using mosquito nets or insecticide sprays. The study concluded that periodic monitoring of new malaria illnesses and proportion of blood smears positive for malaria parasites in children aged 0-35 months should be introduced into health centre practice in Kenya. This catchment area approach could be used to monitor malaria control programmes as well as predicting malaria epidemics.[63]

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APPENDIX 1

Schedule of Activities and Budget

2001

ACTIVITY	ORGAN(S) RESPONSIBLE	VENUE	MONTH(S)												BUDGET (US$)
			J	F	M	A	M	J	J	A	S	O	N	D	
Proposal development	Researcher, Supervisors	Nairobi													*125.00*
Review of proposal by ethical committee	Ethical committee	Nairobi													*62.50*
Training of field assistants	Researcher	Mwea													*62.50*
Purchase of materials	Researcher	Nairobi													*750.00*
Pre-testing of data collection instruments	Researcher, field assistants	Mwea													*112.50*
Data collection	Researcher, field assistants	Mwea													*2187.50*
Supervision of field work	Supervisors	Mwea													-
Data analysis	Researcher, statistician	Nairobi													*187.50*
Writing of report	Researcher	Nairobi													*118.75*
Thesis defence	Researcher	Department of Community Health, University of Nairobi													-
Stipend															*1638.00*
Contingencies															*520.00*
															GRAND TOTAL = 5764.25

APPENDIX 2

Questionnaire

DETERMINANTS OF MALARIA IN IRRIGATED AND NON-IRRIGATED VILLAGES OF MWEA: A COMPARATIVE ASSESSMENT

INSTRUCTIONS FOR INTERVIEWER

Interview all heads of households and mothers/caretakers of children below 9 years of age, in selected households. For part two of the questionnaire, fill in one questionnaire per child. Circle or tick the appropriate response.

Write down answers legibly where applicable or if response is not covered by checklist. If the respondent does not know the answer, indicate this.

Introduce yourself as follows:

[*Appropriate greeting*]

My name is [*interviewer's name*] and I am doing health research in this community. I am trying to learn more about health problems here. I am very grateful to you for agreeing to talk with me. May I ask you a few questions about yourself and about malaria?

COMMUNITY DIAGNOSIS QUESTIONNAIRE - MWEA

CODE FOR TABLE ON PAGE 1 OF QUESTIONNAIRE

(i) Relationship to Head of Household

1. Head of household	2. Spouse	3. Son
4. Daughter	5. Brother	6. Sister
7. Grandson	8. Granddaughter	9. Father
10. Mother	11. Other relative	12. Other/non-relative

(ii) Marital Status

1. Married	2. Single	3. Separated	4. Divorced

(iii) Occupation

1. Salaried employment	2. Self-employment	3. Farmer
4. Unemployed/Retired	5. Other (e.g. student)	

(iv) ***Sex*** → M - Male F - Female

(v) ***Age*** → Ask date of birth then calculate and record exact age.

(vi) Education Status

1. Informal	2. Pre-school
3. Lower primary (class 1-4)	4. Upper primary (class 5-8)
5. Secondary and high school (form 1-6)	6. College
7. University	

(vii) Religion (specific church)

1. Catholic	2. Protestant	3. Muslim	4. Other (specify)

COMMUNITY DIAGNOSIS QUESTIONNAIRE - MWEA

PART ONE

SECTION 1 – DEMOGRAPHY

DATE OF INTERVIEW________________________ INTERVIEWER______________________________________

VILLAGE (Encircle appropriate response) → 1. Ciagi-ini; 2. Kagio; 3. Mbui Njeru; 4. Murinduko HOUSEHOLD NO.__________

A. REGISTRATION

1. Name of Head of Household (Give first name and surname):____
2. How many people (live in your) are part of your household:___________
3. Name of respondent (Give first name and surname):____

NO.	NAME (Give first name and surname for head of household/spouse and first and second names for others)	RELATIONSHIP TO HoH	MARITAL STATUS	OCCUPATION	SEX	DATE OF BIRTH	AGE	LEVEL OF EDUCATION	RELIGION
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

B. VITAL STATISTICS

Births

4. Have members of the household been born alive in the last one year? (Encircle appropriate response)

1. Yes 2. No

If 'Yes', list names.

1. ______________________________ 2. ______________________________

3. ______________________________ 4. ______________________________

Deaths

5. Have any household members died in the last one year? (Encircle appropriate response)

1. Yes 2. No

If 'Yes', list name, sex, and cause of death. (Use the code below for cause of death)

NO.	NAME	SEX	CAUSE OF DEATH (Enter code)
1			
2			
3			

CODE →	1. Illness	2. Accident	3. Others (specify)

C. MIGRATION PATTERN

In-migration

6. Has anybody moved into the household from outside the village and has stayed for the past 3 months?

1. Yes 2. No

If 'Yes', proceed to table below.

NO.	NAME	WHERE FROM	REASON
1			
2			
3			
4			

REASONS CODE:

1. Education	2. Employment	3. Marriage	4. Security reasons	5. Other e.g. land acquisition

NB: Marriage and long-term imprisonment (>5 Yrs.) can be included even if 3 months have not elapsed.

Out-migration

7. Has any member of your household moved outside this village and has not come back for more than 3 months?

1. Yes 2. No

If 'Yes', proceed to table below. (NB. Students in boarding school are not considered to have migrated.)

NO.	NAME	SEX	AGE	WHERE TO	REASON (Enter code)
1					
2					
3					
4					

REASONS CODE:

1. Education	2. Employment	3. Marriage	4. Security reasons	5. Other e.g. land acquisition

SECTION 2 – MORBIDITY

PART A: RECALL (2 weeks)

8. Has any member of your household been ill within the last two (2) weeks? (Encircle appropriate response)

   1. Yes 2. No

IF NO, PROCEED TO PART B (Q. 23, PAGE 8)

9. If yes, fill in the following section.

   Name of sick person (patient): ____________________

   Name of illness: ____________________

   Symptoms: ____________________ ____________________

   ____________________ ____________________

   ____________________ ____________________

10. Was any action taken? (Encircle appropriate response)

    1. Yes 2. No

IF NO, GO TO Q. 14

11. What action was taken? (Specify)____________________
12. For how long did the patient stay without treatment before action was taken? (Specify)____________________
13. Why did the patient delay (if delay is indicated in Q. 11) before seeking treatment?

    ____

    ____

GO TO Q. 15

14. Why was action not taken? (Encircle appropriate response)

    1. Illness not serious 2. Illness at early stage

    3. No time to look for treatment 4. No money to pay for treatment

    5. Religion does not allow 6. Distances to facility is far

    7. Unfavourable interpersonal relationship with the caregiver

    8. Others, specify ____________________

GO TO Q. 23

	SOURCE OF HEALTH CARE							
	Health facility			*Medicine from retail shop*	*Medicine bought from pharmacy without prescription*	*Modern medicine in the home*	*Herbs as home remedy*	*Traditional healer sought*
	Govt.	*Mission*	*Private*					
15. Where did the patient go for health care (treatment)? **Fill in the code for the corresponding choice in the appropriate column.**								
01 - 1st choice; 02 - 2nd choice; 03 - 3rd choice; 04 - 4th choice; 05 – 5th choice; 06 - 6th choice.								
16. Why did the patient choose this health care provider? **Fill in by ticking the appropriate column against the appropriate reason(s).**								
01. Services are free								
02. Services are cheaper								
03. You get better treatment								
04. Medical personnel are qualified								
05. Medical personnel are co-operative								
06. The services are available e.g. laboratory, X-ray								
07. Short distance								
08. Transport is available (facility easily accessible)								
09. Seriousness of illness								
10. Recommended by someone								
11. Other (specify) ____________								
12. Other (specify) ____________								
13. Other (specify) ____________								
14. Other (specify) ____________								
15. Other (specify) ____________								

	SOURCE OF HEALTHCARE							
	Health facility			*04. Medicine from retail shop*	*05. Medicine Bought from pharmacy without prescription*	*06. Modern medicine in the home*	*07. Herbs as home remedy*	*08. Traditional healer sought*
	01. Govt.	*02 Mission*	*03. Private*					
17. How far is it to the health care provider you consulted? **Indicate the estimated distance in Km in the appropriate column.**								
18. How would you assess treatment/medicine you received? **Write the code in the appropriate column.**								
CODE: 0. Poor: 1. Fair: 2. Good : 3. Excellent								
19. How would you assess the competence of people who treated you/ or gave you medicine? **Write the code in the appropriate column.**								
CODE: 0. Poor: 1. Fair: 2. Good : 3. Excellent								
20. How would you assess their behaviour? **Write the code in the appropriate column.**								
CODE: 0. Poor/hostile 1. Fair/co-operative 2. Good/friendly 3. Excellent 4. Other (specify)________________								

21. What happened after the patient was treated? (Encircle appropriate response)

1. Cured 2. Improved 3. No change 4. Worsened 5. Died

Now I would like to ask you how much money you spent on the treatment of the illness suffered by this person.

22. Could you please estimate how much it cost for services offered? [In Kenya shillings]

HEALTH CARE PROVIDER	CHARGES FOR CONSULTATION	LABORATORY CHARGES	CHARGES FOR MEDICINE	IN-PATIENT ACCOMMODATION	OTHER ACCOMMODATION	OTHERS (e.g. transport)	CONSOLIDATED MEDICAL BILL (if a breakdown of charges is not given).
Government health facility							
Private hospital or clinic							
Missionary hospital or clinic							
Traditional healer							
Self medication							

PART B: Perception and Behaviour

23. What do you know about the cause/transmission and prevention of the following diseases? **List down response(s).**

DISEASE	TRANSMISSION/CAUSE	PREVENTION
Malaria		
Typhoid		
Bilharzia (schistosomiasis)		
Diarrhoea Disease		
RTI (Respiratory Tract Infection)		
STI (Sexually Transmitted Infection)		
HIV/AIDS		

ECTION 3 – NUTRITION (Respondents are women of child bearing age 15-49)

ame of respondent: ______________________

ame of last child ____________

BREAST FEEDING PRACTICES (FOR WOMEN NOT CURRENTLY BREAST FEEDING)

Are you currently breast-feeding?

1. Yes   2. No   ***(IF YES, GO TO Q. 33)***

Did you breast feed your youngest child? (Encircle appropriate response)

1. Yes
2. No   ***(IF NO, WRITE DOWN EXPLANATION, THEN GO TO Q. 42)***

Explanation ____

____

How soon after delivery did you start breast-feeding? (Encircle appropriate response)

1. Within first six hours
2. Between 6 and 12 hours
3. After 12 hours

If not within 6 hours, what was the reason?

1. Child taken to nursery
2. Child unwilling to suckle/unwell
3. Mother unwell/sedated/post operation
4. Breast problems
5. Lack of milk
6. Others (specify) ____

How often did you breast feed your last child in the:

A) First 4 months

1. On demand
2. On schedule (specify number of times per day) ______________________
3. Other (specify) ____

B) After 4 months

1. On demand
2. On schedule (specify number of times per day) ______________________
3. Other (specify) ____

29 (a) At what age did you introduce other (weaning) foods? (Specify age in months) ______________

(b) What foods did you give the baby?

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

30. For how long did you breast feed your youngest child?

(Specify length of time in months) ______________________________

31. Why did you stop breast feeding your youngest child at that age? (Encircle appropriate response)

1. To resume work
2. Mother was sick
3. Another pregnancy
4. Child old enough
5. Other (specify) ______________________________

32. (a) Did you have any breast feeding problems? (Encircle appropriate response)

1. Yes 2. No

(b) If yes, what problem(s)?

1. Insufficient milk
2. Breast problem (infection, e.g.)
3. Child problem (specify) ______________________________
4. Other (specify) ______________________________

FOR MOTHERS BREAST FEEDING AT THE TIME OF THE STUDY

How soon after delivery did you start breast-feeding? (Encircle appropriate response)

1. Within first six hours
2. Between 6 and 12 hours
3. After 12 hours

If not within 6 hours, what was the reason? (Encircle appropriate response)

1. Child taken to nursery
2. Child unwilling to suckle/unwell
3. Mother unwell/sedated/post operation
4. Breast problems
5. Others (specify) ______________________________

____

5. How often are you breast feeding/did you breast feed your child in the:

A) First 4 months

1. On demand
2. On schedule (specify number of times per day) ____________________
3. Other (specify) ____________________

B) After 4 months

1. On demand
2. On schedule (specify number of times per day) ____________________
3. Other (specify) ____________________

6. Have you introduced other foods apart from breast milk?

1. Yes 2. No ***(IF NO, SKIP TO Q. 42)***

7. At what age did you introduce these (weaning) foods? (Specify age in months) ____________

8. What was the first fluid you gave your child? (Encircle appropriate response)

1. Plain water
2. Sugar water
3. Gripe water
4. Fruit juice
5. Cow milk
6. Other (specify) ____________________

What was the first semisolid food you gave your child?

1. Uji (specify type) ____________________
2. Mashed foods (specify) ____________________
3. Mashed fruits (specify) ____________________
4. Others (specify) ____________________

Why did you introduce weaning foods? (Encircle appropriate response)

1. Insufficient breast milk / baby not satisfied
2. Advice from other women
3. Advice from MCH clinic
4. Resumption of work / unavailability
5. Other (specify) ____________________

How often in a day are/were weaning foods given? (Specify number of times per day) ________

:. CHILD CARE PRACTICES *(For children under five years of age)*

2. Who usually takes care of the child while you are absent from home? (Encircle appropriate response)
   1. Child always accompanies the mother
   2. Sister less than 12 years
   3. Sister more than 12 years
   4. Brother less than 12 years
   5. Brother more than 12 years
   6. Relative (specify)________________________________
   7. Neighbour
   8. House help
   9. Other (specify) ________________________________

43. For how many days last week were you away from home without taking the baby with you?
    (Specify number of days) _______

4. What other activities does the person carry out when left to take care of the child? (Encircle appropriate response)
   1. Household chores
   2. Care for other children
   3. Gardening
   4. Other (specify) ________________________________

5. In which of the following activities does the father often, participate? (Encircle appropriate response)
   1. Hold and play with the baby
   2. Wash and change the baby
   3. Feed the baby
   4. Provide money for child health care
   5. Other (specify) ________________________________

How do you know if your child is NOT growing well? (Encircle appropriate response)
   1. I don't know how to assess
   2. No weight gain
   3. Skin and hair changes
   4. No height gain
   5. General ill health
   6. Others (specify) ________________________________

Where do you receive health care/information for your child/children? (Encircle appropriate response)

1. Do not receive
2. Health facilities e.g. health centre, hospital
3. Relatives
4. Friends
5. Traditional Birth Attendant
6. Medicine men
7. Traders
8. Media (radio)
9. Other (specify) ____________________ ____________________

____________________ ____________________

____________________ ____________________

What do you do when your child refuses to eat? (Encircle appropriate response)

1. Use force
2. Leave the child alone
3. Threats/scolding
4. Give alternative foods
5. Persuasion
6. Other (specify) ____________________ ____________________

____________________ ____________________

____________________ ____________________

NUTRITION FOR THE WHOLE FAMILY

NB: The respondent will mention the meal e.g. ugali and sukuma wiki; the interviewer will probe and tally accordingly, recording the food eaten by adults and that eaten by children under 5 yr. in the respective columns.

hat types of food has the amily taken in the last 24 ours?	**Record the frequency as per the specific food in the table.**				**Where did you obtain these foods?** (Tick appropriate box)		
	ADULTS		***UNDER FIVES***		*Farm produce*	*Bought*	*Given*
	Tally	*Total*	*Tally*	*Total*			
arbohydrates							
gali (maize meal)							
laize							
ananas							
rrow roots							
ice							
otatoes							
ji (porridge)							
thers (specify)							
Proteins							
eans/peas							
leat/chicken							
ish							
ggs							
lilk							
thers (specify)							
ats							
ommercial vegetable fats							
nrefined animal fats							
egetable/fruits							
ukuma wiki (kale)							
abbages							
omatoes							
arrots							
ruits							
thers (specify)							
everages							
uices							
lcohol							
lack tea/coffee/etc							
thers (specify)							

SECTION 4 – MCH/FP (Mothers aged 15-49 years)

Name of respondent: ______________________________

Name of last child ______________

ANTENATAL CLINIC AND MATERNITY SERVICES

50. Are you pregnant or have you been pregnant before? (Encircle appropriate response)

1. Yes 2. No *(IF NO, GO TO Q. 62)*

51. Are you attending/did you attend the antenatal clinic (ANC) during your present/last pregnancy? (Encircle appropriate response)

1. Yes 2. No *(IF NO, GO TO Q. 55)*

52. Where did you go for ANC? (Encircle appropriate response)

1. Health centre
2. Private hospital/clinic
3. District hospital
4. Traditional Birth Attendant (TBA)
5. Others (specify) ______________________________

53. How many months pregnant were you when you began to attend ANC? ______________ months.

54. At the clinic, what did they do? List what was done.

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

(GO TO Q. 56)

If you did not attend ANC, give reasons.

1. Distance too far
2. Not aware
3. Too busy
4. Not important
5. Spouse refusal
6. Religion
7. Costs
8. Others (specify) ______________________________

Where was your youngest child delivered?

1. Dispensary
2. Private clinic/hospital
3. District hospital
4. At home with a Traditional Birth Attendant (TBA)
5. At home alone/with an unqualified person
6. Others (specify) ______________________________

57. What was the reason for delivering where you did?

1. Costs
2. Accessibility
3. Better services available
4. Complications
5. Spouse advice
6. Others (specify) ______________________________

D: GROWTH MONITORING AND IMMUNISATION

58. Do/did you take your last child for 'clinic'?

1. Yes 2. No ***(IF NO, GO TO Q. 61)***

9. Where do/did you take your child for these services? (Encircle appropriate response)

1. Dispensary
2. Health centre
3. Hospital
4. Private clinic
5. Others (specify) ______________________________

Ask for clinic card. Determine the immunisation status by observing the clinic (immunisation) card. (Encircle appropriate response)

1. Immunisation up to date
2. Partly immunised
3. Not immunised

(GO TO Q. 62)

MK2003

If you do/did not take your child for growth monitoring and immunisation, give reasons. (Encircle appropriate response)

1. Distance
2. Not important
3. Cost
4. Not aware
5. Spouse refusal
6. Religion
7. Others(specify) ______________________________

: FAMILY PLANNING

2. Have you ever used a family planning method? (Encircle appropriate response)

1. Yes 2. No ***(IF NO, GO TO 72)***

3. Are you currently using a family planning method? (Encircle appropriate response)

1. Yes 2. No ***(IF NO, GO TO 71)***

Which method are you using? (Encircle appropriate response)

1. Pill	2. Traditional methods	3. Tubal ligation
4. Vasectomy	5. Norplant	6. Condom
7. Injectable	8. IUD	9. Diaphragm

10. Others (specify) ______________________________

Where do you get your family planning services? (Encircle appropriate response)

1. Dispensary
2. Health centre
3. Friend/relative
4. Neighbour
5. Shop/chemist
6. Community health worker
7. Others (specify) ______________________________

Does the person who offers family planning services to you provide information on other methods available, their advantages & disadvantages? (Tick appropriate response)

	No	Yes
Provide information		
Other methods available		
Advantages of the methods		
Disadvantages of the methods		

7. Are you happy with the method you are using (Encircle appropriate response)

1. Yes 2. No ***(IF YES, GO TO 69)***

8. If no, why not? (Encircle appropriate response)

1. Health reason (specify) ______________________________
2. Convenience
3. Culture/local customs
4. Cost
5. Others (specify) ______________________________

Have you ever changed from one method to another? (Encircle appropriate response)

1. Yes 2. No ***(IF NO, GO TO 73)***

Why did you change? ______________________________

(GO TO 73)

Which method did you use? (Encircle appropriate response)

1. Pill
2. Traditional methods
3. Tubal ligation
4. Vasectomy
5. Norplant
6. Condom
7. Injectable
8. IUD
9. Diaphragm
10. Others (specify) ______________________________

(GO TO 73)

If no, why not?

1. Not aware
2. Culture
3. Not important
4. Religion
5. Spouse refusal
6. Others (specify) ______________________________

CTION 5 – ENVIRONMENTAL HEALTH

WATER

How much water is available in the household per day? (Indicate) ____________ *litres.*

[Calculate average amount per individual per day] (Indicate) _________ *litres per person per day.*

: What are your sources of water? (Tick appropriate box)

SOURCE	DOMESTIC	DRINKING
River/stream		
Tap		
Hand-dug well		
Roof run off (rain water)		
Bore hole		
Irrigation canal		
Other (specify)____________________		

75. Do you treat your water before drinking? (Encircle appropriate response)

1. Yes 2. No

6. If 'Yes', how do you treat it? (Encircle appropriate response)

1. Boil
2. Chlorination
3. Filtration
4. Others (specify)____

7. If chlorination or filtration, explain what is done.

____

____

8. Could you show me where you store your drinking water? (Interviewer should observe then circle appropriate item)

1. Covered and in clean container (good)
2. Covered but in a dirty container or uncovered but in a clean container (fair)
3. Uncovered and in a dirty container (poor)
4. Others (specify)____

____

Do you know any diseases related to consumption of untreated water? (Encircle appropriate response)

1. Yes 2. No

If 'Yes', which ones? (List them)

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

B. HOUSING UNITS

81. Indicate the type of housing material used for the: (interviewer should also observe, then encircle the appropriate item)

- *Roof* → 1. Iron sheets 2. Roof tiles 3. Grass
- *Floor* → 1. Cemented 2. Earthen 3. Wooden
- *Walls* → 1. Iron sheets 2. Wooden 3. Stone 4. Mud 5. Red bricks 6. Concrete blocks

82. What type of house is it? (Interviewer should also observe, then encircle appropriate item)

1. Temporary 2. Semi-permanent 3. Permanent

83. Is the house: (Circle appropriate item)

1. Owned 2. Rented 3. Other (specify) ________________________

84. How many sleeping rooms are there in the house? ____________________

85. How many people sleep in each room?

ROOM →	ROOM 1	ROOM 2	ROOM 3	ROOM 4
NUMBER OF OCCUPANTS →				

86. How many of the following features are there in each sleeping room? (Indicate number in the appropriate box)

ROOM →	ROOM 1	ROOM 2	ROOM 3	ROOM 4
Number of screened windows				
Number of unscreened windows				
Number of beds				
Number of bed nets				
Screened eaves				
Unscreened eaves				

87. Who sleeps under the bed nets? (Specify) ____

SANITATION

What means of excreta disposal do you have in the homestead? (Encircle appropriate response)

1. Ordinary pit latrine
2. Ventilated Improved Pit (VIP) latrine
3. Flush toilet
4. Others (specify)________________________________

) Where do you go to relieve yourself while in the rice fields? (Encircle appropriate response)

1. Ordinary pit latrine 2. VIP-type pit latrine 3. Feeders
4. Rice paddy 5. Irrigation canals 6. Drains
7. Others (specify) ________________________________

) Do you know of any diseases associated with poor excreta disposal? (Encircle appropriate response)

1. Yes 2. No

1. If 'Yes', which ones? (Encircle appropriate response)

1. Polio 2. Liver disease 3. Cholera 4. Amoebiasis
5. Typhoid 6. Eye disease 7. Bilharzia
8. Others (specify) ________________________________

2. Where do you and other family members usually take their bath? (Specify) ______________

3. Where do children under five usually take their bath? (Specify) ______________

4. Where are the clothes usually washed? (Specify) ______________

). OBSERVATIONS

5. Observe the general cleanliness of the homestead. (Encircle appropriate item)

1. Very clean (well swept, no litter or empty cans, no overgrown bushes)
2. Clean (if at least one but not all of the above factors are violated)
3. Unclean (littered, overgrown bushes, unkempt)

. Estimate the distance between the cowshed and the main house. ______________*metre*

7. Estimate the distance between the nearest rice paddy and the main house. ______________*metre*

General condition and description of pit latrine: (Encircle appropriate items)

1.	Private	1. Yes	2. No
2.	Dry	1. Yes	2. No
3.	Clean	1. Yes	2. No
4.	Cemented floor	1. Yes	2. No
5.	Hole covered	1. Yes	2. No
6.	VIP type latrine	1. Yes	2. No
7.	More than 15 m away from water source	1. Yes	2. No
8.	More than 15 m away from kitchen	1. Yes	2. No

9. If water source is a hand-dug well: (Encircle appropriate items)

1.	Covered	1. Yes	2. No
2.	Raised	1. Yes	2. No
3.	Cemented sides	1. Yes	2. No
4.	Permanent vessel for drawing water	1. Yes	2. No

E. AGROCHEMICALS

100. Do you use any agrochemicals? (Encircle appropriate response)

1. Yes 2. No

101. If 'Yes', list the ones you have. (Interviewer should observe and indicate by ticking appropriate column whether they actually saw the agrochemical or its presence was merely reported).

AGROCHEMICAL NAME	SEEN	REPORTED

02. How do you use them? (Encircle appropriate response)

1. Spraying using pumps
2. Sprinkling using leaves
3. Sprinkling using hands
4. Pouring from a tin
5. Other (specify)____

103. What precautions do you take? (Encircle appropriate response)

1. Wash hands with soap and water after use
2. Use of gloves
3. Use of facemask
4. Use of gum boots
5. Use of goggles
6. Other (specify)____

104. Where do you store them? (Encircle appropriate response)

1. Bedroom
2. Dining room
3. Kitchen
4. Store
5. Other (specify)____

105. How long after applying the pesticide, do you harvest the crop? (Indicate crop and duration)

CROP	DURATION

106. Where do you get knowledge of how to apply and when to re-enter the field after applying pesticide? (Encircle appropriate response)

1. Container (instructions)
2. Agricultural extension officer
3. Radio
4. Papers
5. Chief's baraza
6. Traders
7. Others (specify)____

107. Do you experience any symptoms after applying pesticides? (Encircle appropriate response)

1. Yes 2. No

108. If 'Yes', which ones? (Encircle appropriate response)

1. Respiratory (breathing)
2. Skin
3. Stomach problems
4. Heart problems (i.e. heart beats fast)
5. Fainting, dizziness, weakness
6. Other (specify)________________________________

SECTION 6 – SOCIO-ECONOMIC STATUS

A. SOCIO-ECONOMIC INDICATORS

109. What are the sources of energy used within the household? [Tick appropriate item]

	COOKING	LIGHTING
1) Firewood		
2) Charcoal		
3) Kerosene		
4) Electricity		
5) Gas		
6) Solar		
7) Generator		
8) Dry cells (torch)		
9) Car battery		
10) Other (specify)	*	*
e.g. rice husks	*	*
	*	*

110. If kerosene or charcoal is used, specify the amount used per week.

____

111. Indicate which of the following property is owned by the household:

Land (indicate size in acres)	
Vehicles (indicate number and type)	
Cattle (indicate number)	
Sheep (indicate number)	
Goats (indicate number)	

CONTINUED ON NEXT PAGE…

Pigs (indicate number)	
Poultry (indicate number)	
Donkeys (indicate number)	
Radios (indicate number)	
Television sets (indicate number)	
Bicycles (indicate number)	
Carts (indicate number)	

B. SOURCES OF INCOME

112. What are the sources of income for the household, and how much is earned from each source, on average, per annum?

SOURCE OF INCOME	AMOUNT PER MONTH	AMOUNT PER ANNUM
Salaries		
Wages		
Profits from business		
Donations/handouts		
Rice		
Hides/skins		
Milk		
Manure		
Eggs		
Sale of animals		
Horticulture		
Maize		
Beans		
Bananas		
Brewing		
Others		
TOTAL AMOUNT		

C. ANNUAL EXPENDITURE

113. How much do you spend on the following?

ITEM	AMOUNT PER MONTH	AMOUNT PER ANNUM
Food		
Education		
House rent		
Clothing		
Medical expenses		
Farm inputs		
Wages/salaries		
Fuel		
Transport		
Recreation/leisure		
Land rent		
Miscellaneous		
TOTAL AMOUNT		

PART TWO

MALARIA PREVALENCE

INSTRUCTIONS FOR INTERVIEWER

Interview all mothers/caretakers of children 0 - 9 years in selected households.

Encircle the appropriate response.

Write down answers legibly where applicable or if response is not covered by checklist. If they do not know the answer, indicate this.

Explain the consent agreement form to the parent/guardian and ensure that it is filled in correctly.

Consent for Minors

I, ______________________________ *(name of parent or guardian)*, being 18 years or older and having full capacity to consent for the children under my care, have been informed about the study entitled: Agroecosystem Management for Community-Based Integrated Malaria Control in East African Irrigation Schemes (The ICIPE-IWMI Project). I have duly been informed that one phase of this study is the determination of the number of children 9 years of age or less with malaria. This necessitates obtaining blood from finger pricks in order to prepare blood films that will then be examined for presence of malaria parasites. I have been informed that this exercise is voluntary and that if a child is found to have malaria, they will receive medical treatment.

My signature below indicates that I have given consent for my child to participate in this study.

I wish my child to participate in this study.

Parent /guardian's signature: ____

Date: ____

Witness's signature: ____

Witness's name: ____

Date: ____

114.Name of subject: ____

115.Has this child had fever within the last three days?

(Encircle appropriate response.) 1. Yes 2. No

16. Has this child had any other symptoms? (Encircle appropriate response[s] in the list below.)

1. Headache;
2. Unconsciousness;
3. Body and joint pains;
4. Convulsions/fits;
5. Feeling cold/shivering;
6. Rapid/difficult breathing;
7. Loss of appetite;
8. Inability to feed/vomiting;
9. Abdominal pains/diarrhoea;
10. Dehydration (dryness of tongue and mouth).

117. Have you given him/her any ***anti-malarial*** medicine in the last 3 days?

(Encircle appropriate response.) 1. Yes 2. No

118. If yes, which ones?

(Indicate:____)

119. Prepare thick and thin blood films. After examination, enter results below.

Result of blood slide examination: (Encircle/enter appropriate response.)

- 1. Positive 2. Negative
- Parasite density: ____
- Parasite species: ____
- Parasite stage: ____