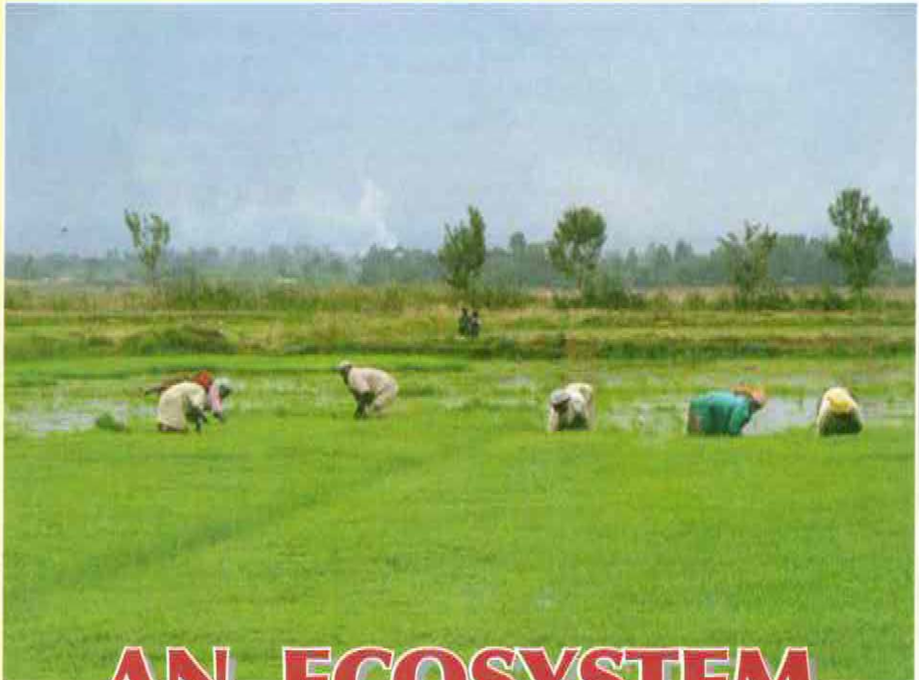

# AN ECOSYSTEM APPROACH TO MALARIA CONTROL IN MWEA

A Collaborative project on Systemwide Initiative on Malaria and Agriculture,
*icipe* – African Insect Science for Food and Health,
International Water Management Institute, University of Nairobi,
Mwea Community, International Development and Research Centre
(2004–2006)

# Acknowledgements

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This study was funded by the International Development and Research Centre (IDRC), Canada, and was spear-headed by the International Centre of Insect Physiology and Ecology (*icipe*), Kenya, and the University of Nairobi, Kenya, with support from several key international collaborating programmes and organisations including Systemwide Initiative on Malaria and Agriculture (SIMA), and International Water Management Institute (IWMI).

# Contents

# IDRC/*icipe*/SIMA/IWMI MWEA Malaria Control Project (2004–2006)

*Kenyan researchers, government departments and local communities stay united in the fight against mosquitoes and malaria in Mwea Irrigation Scheme.*

## Background

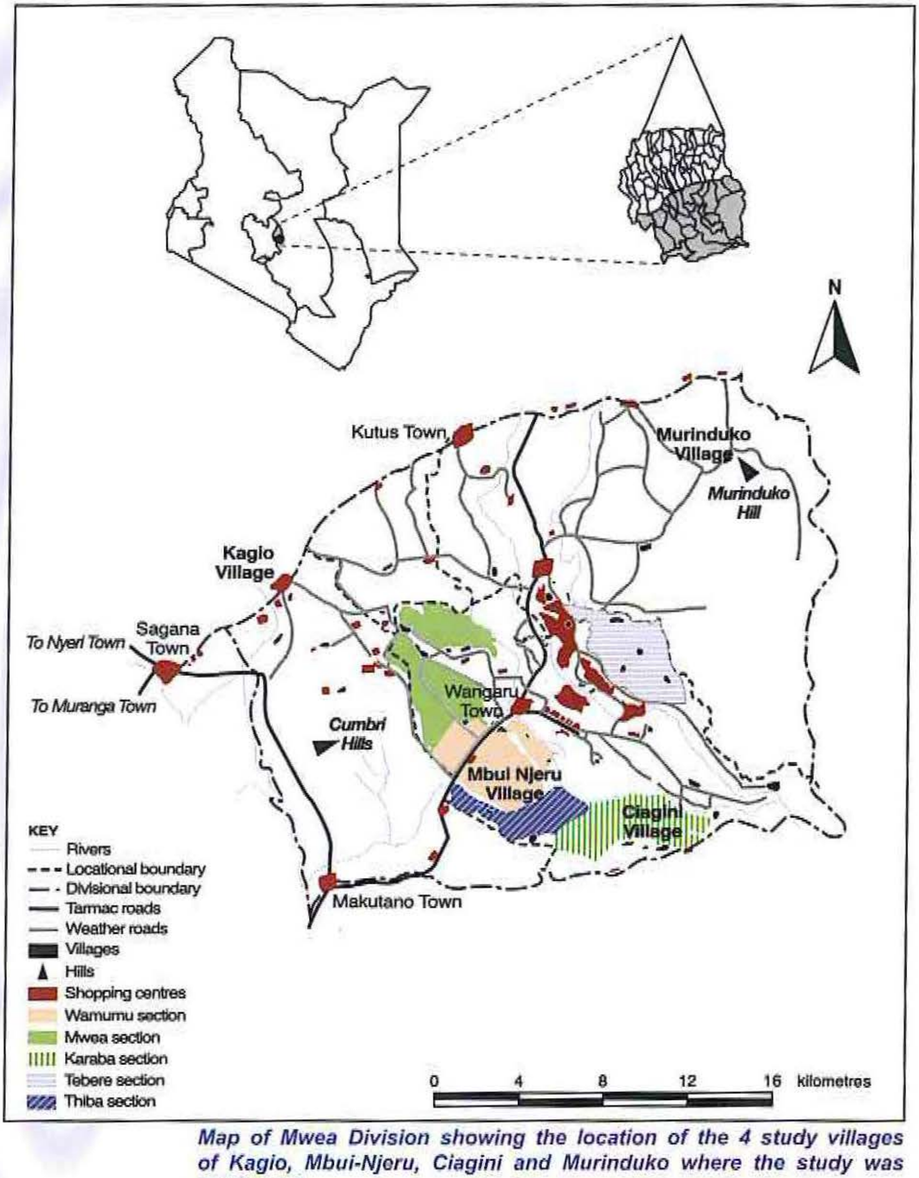
### The Global Malaria Challenge

Malaria affects 300–500 million people each year, resulting in the deaths of at least 1 million over the same period. More than 90% of the morbidity and mortality due to malaria occurs in sub-Saharan Africa. Measured in terms of disability-adjusted life-years, malaria is one of the major disease burdens worldwide. The financial implications of malaria costs Africa more than US$ 12 billion annually when the cost of diagnosis and treatment and investment in preventive measures are considered. Malaria has slowed economic growth in Africa leading to a reduction in gross domestic product (GDP) up to 32% lower had the disease been eradicated from the continent in the early 1960s.

Malaria causes over 900,000 deaths and the conomic loss of US$ 12 billion each year in Africa.

### Malaria Challenge in Mwea Irrigation Scheme

The mosquito nuisance and malaria threat have long been recognised as among the main health problems afflicting the rice-farming community in the Mwea rice irrigation scheme. Irrigated farming, in spite of being widely accepted and practised as a means of increasing food production, often leads to some unintended negative impacts on human health: Malaria and bilharzia (schistosomiasis) are among the two diseases most commonly associated with irrigation in Kenya and most other African countries. The malaria problem arises principally from agricultural activities which provide favourable conditions for the breeding and survival of *Anopheles* mosquitoes, the vectors of malaria. Excess surface water, use of pesticides and the




***Map of Mwea Division showing the location of the 4 study villages of Kagio, Mbui-Njeru, Ciagini and Murinduko where the study was conducted***

keeping of livestock, particularly cattle, all play a role in malaria transmission risk. Improved management of the agro-ecosystem can therefore significantly reduce the incidence of disease. Besides the widespread ill-health in Mwea due to malaria, the financial implications of the disease remain enormous.

The Mwea malaria control project in Kenya, implemented between 2001–2006, was designed to contribute to mitigating this challenge. The project was spearheaded by the International Centre of Insect Physiology and Ecology (*icipe*) and the University of Nairobi, with support from several key international collaborating programmes and organisations including the Systemwide Initiative on Malaria and Agriculture (SIMA), International Development Research Centre (IDRC), and International Water Management Institute (IWMI). The project worked closely with the Ministries of Health, Education and Agriculture and community groups.

## Project Site

### *Location and climate*

The Mwea Rice Irrigation Scheme is located in the central region of Mwea Division and covers an area 13,640 ha. Mwea occupies the lower altitude zone of Kirinyaga District in an expansive low-lying area, mainly characterised by black cotton soils. The Mwea malaria control project is 100 km north east of Nairobi. The mean annual rainfall is 950 mm with a maximum in April/May (long rains) and October/November (short rains). The average maximum temperatures are in the range of 16–26.5 °C and relative humidity varies from 52–67%.

### *Population*

According to the 1999 national population census, Mwea Division had a population of approximately 150,000 persons in 25,000 households.

The multisectoral project operated on three pillars: transdisciplinarity, wide-scale participation and gender sensitivity.

## History of Mwea Malaria Control Project

The history of this second phase of the project has its roots in the first phase (2001–2003) whose objective was to characterise the entire ecosystem to identify opportunities *for improving human health and enhance household incomes through better management of local resources*. The project used an ecosystem approach to human health. The approach recognises that human health and well-being are intimately tied to the health of the ecosystems that sustain life. The project therefore works at the intersection of the three main systems: the environment, the economy and society. The approach has three key pillars, namely transdisciplinarity, participation and gender sensitivity. Use of this approach in the project built ownership and introduced the basics of sustainability through participation, full engagement of local institutions and building of local capacity.

The results of this characterisation revealed that malaria is a major concern in Mwea, both in the irrigated and non-irrigated areas; the malaria risk is highly associated with irrigated farming practices. There was a significantly higher vector population in the irrigated villages compared to the non-irrigated sites. This was attributed to the prolonged (essential and non-essential) flooding of paddies which encouraged continuous breeding of the vector. The results further showed high levels of poverty (a constraint to good health) and poor nutrition in the local community. Vital resources (land, labour, water) were left idle during the off-season for rice growing. Other work in Mwea indicated declining soil fertility, resulting in lower rice yields due to steady depletion of soil nutrients by continuous mono-cropping of rice.

Overall, the results of this characterisation improved the understanding of interactions between environmental and socio-economic factors, and how these might explain the prevailing picture of malaria endemicity.

This second phase of the project (2004–2006) was built on recognition that improved community access to knowledge and the implementation of integrated vector management (IVM) would have a great impact on alleviating the burden of disease among the communities. It combined research and interventions on critical issues identified during the first phase.

A complete picture of malaria in Mwea relies on understanding the interactions between environmental and socio-economic factors.

## The Mwea Phase-Two Malaria Control Project (2004–2006)

### Goal

Malaria reduction resulting in improved human health and well-being, increased agricultural productivity and poverty alleviation.

### General Objective

To develop and apply a development-oriented strategy for sustainable reduction of malaria among rural communities in central Kenya.

### Specific Objectives

- strengthen cooperation between communities, government departments, and international and non-governmental organisations in malaria control;
- evaluate the impact of integrated anti-malarial interventions on malaria vector populations and prevalence of malaria parasites in the population;
- assess people's behavioural change towards malaria control actions when interventions are integrated and conveniently phased in the context of an ecosystem approach to human health;
- To conduct further research on the feasibility of seasonally rotating the cultivation of rice and soybean as an agro-ecosystem strategy for simultaneously enhancing household incomes, improving nutrition and reducing malaria vector breeding habitats;
- disseminate information across all levels.

### Main Components

- malaria control
- entomological studies
- parasitological studies
- promotion of integrated vector control (IVM), including bednets.

## Methodology

The project combined research and interventions. Interventions supported malaria control activities through education, provision of mosquito nets and environmental management, while research focused on entomology, parasitology and vector control through rotation of soya and rice cropping.

### Project Sites

The project worked in the four villages characterised in the first phase of the project. The villages were Mbui-Njeru and Ciagi-ini (both irrigated), and Murinduko and Kagio/ Kiamaciri (non-irrigated). This second phase of the project worked with a total of 3880 people in 621 households (families) and 8 primary schools with a total population of 441 schoolchildren.

*Pools left behind following transplanting of rice form important habitats for mosquito breeding in rice agro-ecosystems*

## *Components*

The project involved over 600 households and 8 primary schools with a total study group of more than 4000 persons.

*RESEARCH ACTIVITIES*

- evaluating the impact of anti-vector interventions on malaria vector populations and malaria prevalence;
- assessing people's behavioural change towards malaria control actions when interventions are integrated and conveniently phased in the context of an ecosystems approach to human health;
- assessing the feasibility of seasonally alternating the cultivation of rice and soya beans as a habitat-based agro-ecosystem management strategy for malaria vector control and enhancing household incomes.

*INTERVENTIONS*

- **Insecticide-treated bednets.** Insecticide-treated bednets (ITNs) were used for personal protection against malaria vectors in order to reduce the number of potentially infective bites from malaria-transmitting female *Anopheles* mosquitoes.
- **Environmental management.** By reducing the environments that promote vector multiplication such as pools of water, tire tracks, garbage etc., number of mosquitoes can be reduced. This component was undertaken by project villages which were mobilised and guided by trainers (ToTs) trained by the project.
- **Larviciding.** Treating mosquito breeding sites was done with anti-larval chemicals in every village which harboured *Anopheles* larvae, that could not be eliminated through environmental management.
- **Knowledge dissemination (health promotion).** The information, Education and Communication component was geared towards creating awareness among communities and schools on the prevention and control of malaria.

Training at all levels resulted in a higher level of awareness among villagers and schoolchildren and increased paricipation in malaria control activities.

## Community and Multi-stakeholder mobilisation and engagement

*MULTISECTORAL INVOLVEMENT*

With the understanding that malaria is greatly influenced by a wide range of ecological and social factors, the project team commanded expertise that cut across a wide range of academic disciplines, including entomology, epidemiology, agriculture, community health and social science. The project also engaged multiple sectors, including the Ministries of Health, Education and Agriculture. The soya/rice research was carried out in collaboration with the National Irrigation Board. This approach was a departure from the more conventional approaches which view malaria control as a domain for clinicians and entomologists only.

*COMMUNITY PARTICIPATION*

This second phase adhered to the principles of participation developed and perfected during the first phase of the project. Participation was built through the following processes:

- Participation in Mwea-wide stakeholder workshop. As key stakeholders, community representatives

*Farmers transplanting rice seedlings in a rice paddy. The foot prints and water puddles are suitable for mosquito breeding* from the project villages participated in a major workshop held in July 2004 to launch the project. Later they went back to their respective areas and shared details of the project with other members of their communities, for wider impact.

- Village-level awareness and planning meetings. To create broad-based knowledge and further awareness, the project facilitated well-attended village-level meetings, resulting in interest and support for the project. Over 165 community members were reached through this process.
- Community ToT training. To build local training capacity, villages identified Community Health Workers (CHWs), of whom 44 were trained as Training of Trainers (ToTs). Those trained in turn trained the communities in different aspects of malaria control, including
  - mosquito habitat and life cycle;
  - cause, spread and protection against malaria;
  - signs and symptoms, especially among babies and young children;
  - environmental management;
  - change of lifestyles, e.g. on health-related behaviour such as self-protection against

***Communities undertake participatory evaluation of the project and share results***

mosquito bites (mosquito nets) and seeking prompt treatment at recognised health institutions;
  - agro-ecosystem management for crops and livestock.
- Training teachersd as ToTs. To extend malaria education to schools, a total of 24 teachers from 8 schools were trained as ToTs. The training covered the same topics as for communities.
- Participatory evaluation of the project. In a highly participatory and interactive manner, all communities took part in evaluation of the project. The evaluation was based on a number of indicators, including level of participation, knowledge and skills gained, and benefits and changes which could be associated with the project work.

## Results

### Participation

*Community participation*

Households participated in the programme in a variety of ways, including receiving and use of insecticide-treated nets (ITNs), training, training others and in environmental management activities in their respective villages.

**Participation statistics**

| Activity | Total |
|---|---|
| Participation in stakeholder workshop | 48 |
| Participation in village-level awareness meetings | 165 |
| Participation in community-level participatory evaluation | 224 |

*Multisectoral involvement*

The project engaged and involved relevant institutions, for example:

- For parasitological surveys, the project used the District health facilities to screen for malaria and treat children under-five years suffering from malaria.

- The office of the Ministry of Health participated actively in the end-of-project community-level project evaluation and the Malaria Day events.
- The project supported a health stakeholders' meeting to help improve coordination and sharing among health stakeholders.
- The Ministry of Education provided guidance and support for the school education programme. The Ministry selected the schools and teachers to be trained and actively participated in the Malaria Day programme during which the pupils performed the music, songs and dances, learned through the programme.
- The National Irrigation Board (NIB) provided the infrastructure for the soya/rice research.

## Malaria Control Strategies

### *Use of treated bednets*

The malaria project distributed a total of 2700 long-lasting insecticide-treated bednets to 621 households (families) covering a population of 3,880 in four villages in 2005. Promotion of ITNs was to help reduce the number of bites from malaria-transmitting female *Anopheles* mosquitoes. The distribution and subsequent monitoring was implemented by Community Health Workers (ToTs).

**Use of ITNs among project households (HH)**

| Village | No. HH | Pre-intervention | | | Post-intervention | | | |
|---|---|---|---|---|---|---|---|---|
| | | No. people | Nets/ person | Persons net | No. people | No. bednets | Nets/ person | Persons net |
| Ciagi-ini | 107 | 444 | 0.25 | 4.07 | 479 | 326 | 0.69 | 1.47 |
| Kagio | 106 | 482 | 0.35 | 2.85 | 493 | 272 | 0.56 | 1.81 |
| Mbui Njeru | 101 | 390 | 0.45 | 2.22 | 427 | 304 | 0.72 | 1.40 |
| Murinduko | 108 | 460 | 0.06 | 16.43 | 486 | 219 | 0.46 | 2.22 |
| **Total/ Mean** | **422** | **1776** | **0.03** | **6.39** | **1885** | **1121** | **0.75** | **2.15** |

### *Environmental management*

The rate of community involvement in environmental management showed a significant increase with regard

*Mbui-Njeru village community receives mosquito nets*

to clearing vegetation in canals with 0.9 and 14.9% of households having reported taking action at the pre-intervention and post-intervention survey, respectively. The proportion of households involved in filling/leveling of breeding sites rose from 23.5% (Pre-intervention) to 30.4% (post-intervention).

**Environmental management activities in the 4 study villages in Mwea Irrigation Scheme**

| | Pre-intervention | | Post-intervention | |
|---|---|---|---|---|
| Activity | No. respondents | % households | No. respondents | % households |
| Filling/leveling breeding sites | 50 | 23.5 | 102 | 30.4 |
| Clearing vegetation in canals | 2 | 0.9 | 50 | 14.9 |
| Clearing HH refuse/proper waste disposal | 99 | 46.5 | 205 | 61 |
| Clearing bushes/vegetation around houses | 168 | 78.9 | 287 | 85.4 |
| Others | 5 | 2.3 | 1 | 0.3 |
| **Total** | **213** | **100** | **336** | **100.0** |

### *Impact on febrile illness episodes*

Records of malaria episodes based on the household questionnaires showed a significant decrease in number of persons reporting to have had fever in the previous two weeks, from 10.2% in the pre-intervention phase to 5.6% post intervention, an indication that the IVM package implemented may have had an impact on disease outcome.

**Reporting of fever in project households (HH)**

| Village | Pre-intervention | | | | Post-intervention | | | |
|---|---|---|---|---|---|---|---|---|
| | Popn. sampled | No. HH reporting fever | No. people with fever | Prop. with fever (%) | HH Popn. sampled | No. people reporting fever | No. Prop. with fever | Prop. with fever (%) |
| Ciagi-ini | 444 | 52 | 54 | 12.2 | 479 | 24 | 24 | 5.0 |
| Kagio | 482 | 39 | 45 | 9.3 | 493 | 14 | 14 | 2.8 |
| Mbui Njeru | 390 | 36 | 38 | 9.7 | 427 | 37 | 40 | 9.4 |
| Murinduko | 460 | 50 | 55 | 11.9 | 486 | 24 | 25 | 5.1 |
| **Total** | **1776** | **177** | **192** | **10.8** | **1885** | **99** | **103** | **5.6** |

### *Malaria prevalence*

Data on malaria prevalence rates was higher in the non-irrigated villages (Murinduko 38%, n = 63; Kiamaciri 1%, n = 85) while no infections were recorded in the irrigated villages (Mbui Njeru, n = 53; Ciagi-ini, n = 29) during the pre-intervention or baseline phase. This may be due to the high bednet coverage and use i the irrigated villages as a result of the high income generated from rice growing. The occurence could also be vector-related with regard to mosquito longevity and zoophily due to high animal

**Malaria parasite prevalence in four project villages**

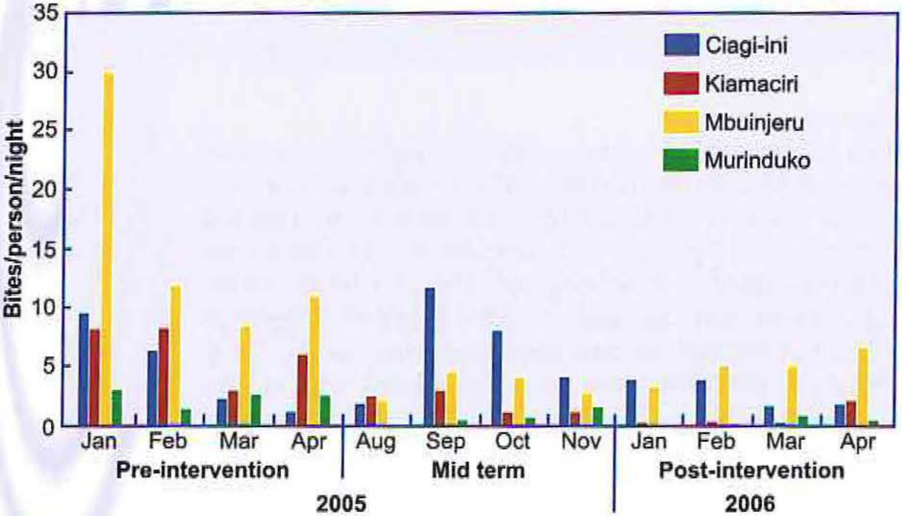
| Village | Pre-intervention | | | Post-Intervention | | |
|---|---|---|---|---|---|---|
| | Total blood films | No. positive | Prevalence (%) | Total blood films | No. positive | Prevalence (%) |
| Ciagi-ini | 29 | 0 | 0 | 121 | 0 | 0 |
| Kagio | 85 | 1 | 1 | 96 | 0 | 0 |
| Mbui Njeru | 53 | 0 | 0 | 73 | 0 | 0 |
| Murinduko | 63 | 24 | 38 | 87 | 0 | 0 |

presence in the irrigated villages. Out of a total of 377 blood films screened during the post-intervention phase, none was found to be positive for malaria parasites.

*Vector densities and biting rates*

There was a significant reduction in vector densities following implementation of the IVM approach, with post-intervention *Anopheles* densities (7.73 *Anopheles*/house) being lower than the pre-intervention measures (20.2 *Anopheles*/house). A total of seven *Anopheles* species were identified showing a high species diversity, with *Anopheles arabiensis* predominating. The relative abundance of *Anopheles* mosquitoes expressed as biting rates (number of bites per person per night) was similarly lower post-intervention (2.23 bites/p/n) compared to the pre-intervention phase (7.3 bites/p/n).

**Mosquito (Anopheles) biting rates in four project villages**




## Key Outcomes

- Significant impact of integrated vector management (IVM) on vector populations and malaria as measured by the incidence of illness episodes among communities and prevalence demonstrated.

- People's knowledge and participation in malaria control actions enhanced through school and community education programmes as assessed by the household and school tests.

## Health Education Outcomes

### *Health education within the community*

Malaria education in the four villages reached a total of about 2000 individuals, and through them, members of their households and the wider community. A high level of sharing this knowledge was reported at the end of the project participatory evaluation, when members of the community who had not participated in any of the fora organised by the project appeared fairly well informed about the project.

**Awareness among schoolchildren from project villages**

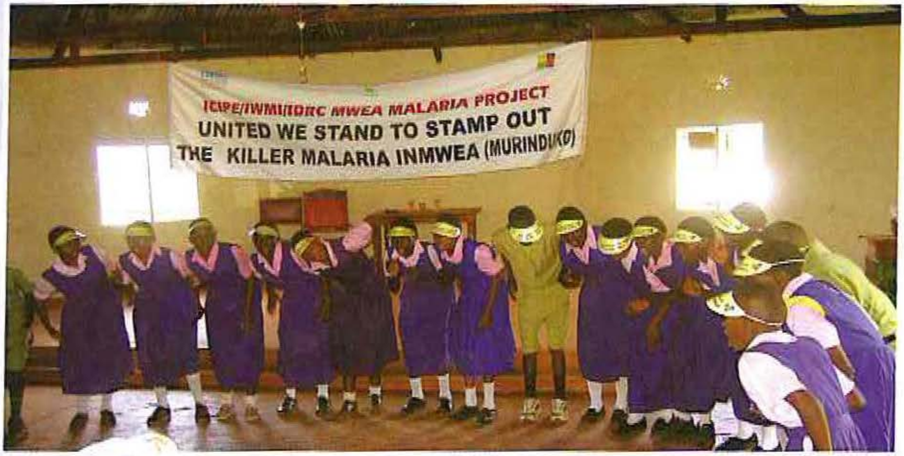
| Question | Response | Pre-Test | | Post-Test | |
|---|---|---|---|---|---|
| | | Responses | Percentage (Frequency) | Responses | Percentage (Frequency) |
| Can malaria be prevented? | Yes | 331 | 89.5 | 303 | 98.4 |
| | No | 29 | 7.8 | 4 | 1.3 |
| | Don't know | 10 | 2.7 | 1 | 0.3 |
| Do you know anything about mosquitoes? | Yes | 339 | 91.9 | 287 | 97.6 |
| | No | 20 | 5.4 | 6 | 2.0 |
| | Don't know | 10 | 2.7 | 1 | 0.3 |
| Does any form of farming contribute to malaria? | Yes | 171 | 61.7 | 207 | 78.4 |
| | No | 75 | 27.1 | 41 | 15.5 |
| | Don't know | 31 | 11.2 | 16 | 6.1 |
| Have you ever been sick with malaria? | Yes | 239 | 89.2 | 244 | 91.4 |
| | No | 29 | 10.2 | 23 | 8.6 |

### *Health education in schools*

Malaria education in schools resulted in improved knowledge among the children targeted (Grade 6) by the project.

By the end of Phase Two of the project, there was an improvement in knowledge about malaria and its causes.

Before the educational intervention, close to 8% of the children reported that malaria is not preventable and this reduced to about 3% during the post-project test. The post-test responses showed that more children had learned about mosquitoes and their role in malaria. After training on malaria control, more children were able to connect some forms of farming to malaria. This was further confirmed during the Malaria / Health Day demonstrations, in drama, poems and songs.




*Children demonstrate their new knowledge gained through the project through song and dance*

It is likely that their newly acquired knowledge on malaria may have resulted in more children looking back on their experiences, thus reporting higher past malaria infections than were recognised at the time.

## Malaria Control through Soya and Rice Rotation

### *Soya–rice system agronomically feasible*

Results of the agronomic studies showed positive effects on soil fertility improvement from growing of soya bean followed by a rice crop. This was clearly demonstrated when the soya-rice treatment was compared with rice-rice and fallow-rice treatments. The fertility response trial showed that rice grown after the soya crop (EAI variety) compared with that of the rice-rice treatment and gave a significantly ($p < 0.05$) higher yield (5531 vs. 4667 kg/ha), the difference being 884 kg/ha (equivalent to 11 bags/ha.).

**Fertility response trial**

| Fertility source | Crop rotation | Rice Grain Yield (Mean, kg/ha) |
|---|---|---|
| EAI (Soya) | soya–rice | 5531 a |
| BOSSIER (Soya) | soya–rice | 5345 ab |
| FALLOW | fallow–rice | 5117 bc |
| RICE | rice–rice | 4667 c |

*Yields followed by the same letter are not significantly different at $P < 0.05$.*

### *Economic benefits to the farmer*

The gross margin analysis from on-station trials indicated multiple benefits in the annual cropping year associated with soya cultivation as follows: Kshs 45,000/ha from direct soya yield (1730 kg/ha @ Kshs 50 = 86,500; less production costs = 41,500/ha) and additional Kshs 21,000 as the quantified value of marginal increase (840 kg/ha @ Kshs 25) in subsequent (after soya) rice yields. The benefits therefore translated into considerable total profit (Kshs 66,000/ha) annually for the farmer. There were positive effects on not only soil fertility (via increase in soil nitrogen), but also on soil structure due to an increase in organic matter. The latter allowed easier working of the normally sticky, black cotton clay soil and the land was easily leveled after soya growing using light equipment. This reduced the cost of land preparation activities, adding to the total monetary benefits resulting from soya cultivation. The data on actual nitrogen and organic matter contents are being finalised.

**Benefits of soybean–rice system quantified**

| Crop | Costs/ hectare (Ksh) | Yield/ hectare (kg) | Value/ income (Ksh) | Gross Margin (Ksh) | Remarks |
|---|---|---|---|---|---|
| Soya crop | 17,000 | 700 | 35,000 | 18,000 | Soil fertility replenished |
| Rice yield increase due to residual fertility | 0 | 340 | 8,500 | 8,500 | Gain from extra rice yielding subsequent (rice) crop following a soya crop |
| Total Benefit/ Profit | | | | 26,500 | |

## *Marketing*

Local soya bean production has been meeting only 5% of domestic demand, the rest being met through imports. The huge imports of raw soybeans implies that there is a market potential of the product locally. The government should protect domestic production by setting appropriate duty levels on imported soybean.

Soybean marketing margins were different from marketing costs, reflecting inefficiency in the market performance. This implies that soybean farmers did not receive their due share in the final consumer price. The study has thus recommended an organised marketing strategy for soybean in Mwea Irrigation Scheme, such as farmers' cooperatives, to improve their bargaining power in the market. It further recommends a processor-grower vertical integration in the form of contract farming in Mwea to ensure sustainability of soybean production and an assured market.

These recommendations reflect a positive projection for soya growing in Mwea in view of the high demand nationally, but only if marketing and the distortions thereof are streamlined to allow farmers to get the right price for their crop. It is apparent from the processors' side that they need an assurance of locally produced bulk supplies such as they currently and consistently obtain from importation. This might be achieved by Mwea farmers organising themselves corporately to respond to this challenge and positioning themselves for higher collective bargaining power in terms of better farmgate prices. Interested stakeholders could help in organising the scheme for both bulk production and marketing.

### *Vector control*

The soya-rice system was found to be effective in vector control by eliminating the mosquito larvae in the soya treatment plots compared to rice-rice and rice-fallow system. Larval density for anopheline species (L1L2,1st instar) in soya, rice, and fallow treatment plots was 0, 198 and 50, respectively and 0, 76 and 12 respectively for L3L4, 2nd instar (see Table below).

The soya bean crop planted in ridges effectively mopped up surface water, hence preventing mosquito breeding, while the rice plots had high larval scores; the fallow plots had intermediate larval levels. The latter two treatments represented the typical production systems practised by farmers in Mwea. Soya bean cultivation alternated with rice cropping therefore has the potential to reduce vector populations and hence could play a significant part of an integrated malaria control strategy.

**Mosquito Larval counts in trial plots in Mwea Irrigation Scheme**

| Mosquito species | Mosquito larvae | Soya | Rice | Fallow |
|---|---|---|---|---|
| Anopheline | L1L2 (1st instar) | 0 | 198 | 50 |
| | L3L4 (2nd instar) | 0 | 76 | 12 |
| Culicine | L1L2 | 0 | 227 | 45 |
| | L3L4 | 0 | 157 | 21 |

Alternating rice with soya

### Conclusions

The project has revealed that alternating a rice monocrop with a soya crop is highly beneficial with respect to increasing household incomes, enhancing nutrition, replenishing soil fertility and improving vector control. This farming system, if adopted scheme-wide, would contribute to improving the habitat management of the Mwea Irrigation Scheme and positively impacting on health and economic empowerment of the local communities.

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CGIAR

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IWMI International Water Management Institute

University of Nairobi

IDRC CRDI

Canada

This multisectoral research and intervention project in Mwea Rice Irrigation Scheme in Kenya's central highlands has demonstrated that alternating a rice monocrop with a soya crop is highly beneficial with respect to increasing household incomes, enhancing nutrition, replenishing soil fertility and improving vector control. This farming system, if adopted scheme-wide, would contribute to improving the habitat management of the Mwea Irrigation Scheme and positively impacting on health and economic empowerment of the local communities.

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