

Farmer Perceptions of Imazapyr-Resistant (IR) Maize Technology on the Control of *Striga* in Western Kenya

An agriculturural collaborative study on *Striga* control by the African Agricultural Technology Foundation and the International Institute of Tropical Agriculture

VM Manyong, SJ Nindi, AD Alene, GD Odhiambo, G Omanya, HD Mignouna and M Bokanga

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- The International Institute of Tropical Agriculture (IITA)
- The African Agricultural Technology Foundation (AATF)

Acronymns and abbreviations

AATF	African Agricultural Technology Foundation
BMI	Body Mass Index
CBOs	Community based organisations
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Center
DAEOs	Divisional Agricultural Extension Officers
DAOs	District Agricultural Officers
DSMS	Divisional Subject Matter Specialists
FEWs	Front-line extension workers
GPS	Global Positioning System
HIV/AIDS	Human Immuno-deficieny Virus/Acquired Immune Deficiency Syndrome
ICRISAT	International Crop Research Institute for the Semi Arid Tropics
IITA	International Institute of Tropical Agriculture
IR	Imazapyr Resistant
KARI	Kenya Agricultual Research Institute
NGOs	Non-Governmental Organisations
OPVs	Open Pollinated Varieties
PCOs	Provincial Crops Officers
PDAs	Provincial Directors of Agriculture
WeRATE	Western Regional Alliance for Technology Evaluation
GLM	Generalised linear model

Summary

For a long time, farmers in Nyanza and Western provinces in Kenya have had to deal with the *Striga* problem. To most of them *Striga* had become a way of life and they had given up hope. *Striga* affects their mainstay crops, which are maize, sorghum and millet. After an extensive search for a solution, IR maize was developed. However, like all new technologies, there is usually suspicion especially from the end user. A study was therefore conducted to find out the level of adoption and perception of farmers on this technology. This study also sought to identify the constraints in the deployment of this technology and arrest them on time. This report presents the findings of this study.

The stratified random sampling method was used to select 10 districts, 16 sub-locations, 32 villages and 834 households. Two groups of farmers were investigated: baseline and WeRATE farmers defined on the basis of number of years of experience with IR maize. A combination of techniques for data collection was used, including literature review, interview of individual households and GPS recordings. Descriptive statistics (frequency of events and means of parameters) were applied for data analysis. Similarly, a binomial probit model was used to identify factors driving the perception of the various households on the IR maize technology.

Findings from sampled households depict that most household heads are male. There were about 26% of households headed by females. The level of education was low for the heads of households and other members of farm families. Group membership was high especially among women. Most households (89%) had received extension visits while 68% had attended field days, seminars and/or agricultural shows.

Farming activities were found to provide a substantial amount of income to most households. Maize is the major food crop and a source of cash income to most households. Farmers grow both local and improved (hybrid) maize varieties, but the productivity of maize is low. There is a considerable gap between potential and actual maize yields. Major factors constraining maize production include *Striga* infestation, drought, erratic rainfall and low soil fertility. *Striga* is by far the major threat to livelihoods of smallholders. Traditional methods of *Striga* control which include uprooting, burning and manuring have proved to be ineffective. Although alternative technologies exist, they have not been highly adopted and used, possibly because of lack of awareness.

Awareness of *Striga* and *Striga* control technologies was substantial among sampled households. All were aware of IR maize technology followed by traditional practices, and push-pull; the least known technology of *Striga* control was the intercropping of legumes followed by cassava/Desmodium. Extension agents from the Ministry of Agriculture and local NGOs were found to be the leading sources of information and demonstrations on various *Striga* control technologies, including instructions/guidelines required before the application of IR maize technology.

Farmers' assessment of maize yields under different *Striga* control technologies revealed that maize yields were higher where farmers used IR maize and push-pull technologies. The least maize yields were observed in fields under traditional *Striga* control technologies. Likewise, IR maize technology was superior in reducing *Striga* population in the fields and control of both biotic and abiotic factors. There were also some implications to the introduction of IR maize technology such as change in weeding times, capital requirement, carefulness in handling farming activities and social implications such as group formation and emergency of credit societies.

The study identified critical ways to speed up the adoption of IR maize technology. The need to establish proper diffusion channels was suggested as an important component before full deployment of this technology. The need to bring IR maize seeds to stockists near to farmers, increase cultivated plots to IR maize and increase IR maize kit and more extension on the technology were highlighted as some of the ways to scale-up the IR maize technology in the region. Other factors that contribute to the positive perception of IR maize, thus to its diffusion and adoption, are farmer perceptions on agronomy attributes of the technology, the number of extension visits, the exposure to the technology, and the responsiveness of the technology to farmer needs.

Chapter 1
Introduction

The Lake zone in western Kenya is a major maize-producing region of the country. Maize is a major staple crop, a source of income and employment for millions of farming families in the region. However, maize production is threatened by a series of production constraints that hamper not only the livelihood of the farming population but also the meeting of the government objectives for agricultural sector transformation. Among these constraints is *Striga* (*Striga hermonthica*) infestation, a parasitic weed which, according to the International Crops Research Institute for Semi Arid Tropics (1996), attaches itself to the maize or sorghum roots from which it draws its moisture and nutrient requirements, inhibiting plant growth, reducing yields and in extreme cases, causing plant death. Woomer et al (2004), painted a grim picture pointing out that *Striga* has so far affected about 75,000ha of maize fields in western Kenya (Western and Nyanza provinces) causing unprecedented estimated losses of US$ 10–38 million per annum. Farmers and various organisations using both traditional and conventional efforts have tried to control *Striga* infestation in the region but results are until recently not promising.

In the wake of working to nourish livelihoods of poor farm families in Africa, the International Wheat and Maize Center (CIMMYT) developed a hybrid maize – Imazapyr Resistant (IR) maize locally referred to as *Ua Kayongo* – to control *Striga*. The African Agricultural Technology Foundation (AATF) is facilitating the deployment of IR maize technology. In the deployment, AATF involves the Western Regional Alliance for Technology Evaluation (WeRATE), agricultural research institutes in Nyanza and Western provinces, and the provincial directorates of the Ministry of Agriculture in the two provinces. The International Institute of Tropical Agriculture (IITA) has been contracted by AATF to follow this technology through conducting a study on assessment of the adoption and impact of IR maize technology on rural livelihoods in western Kenya. IITA completed the first phase of the study, which was carrying out a baseline study on *Striga* control using *Ua Kayongo* technology in 2005/2006. The baseline study helped to establish a benchmark (before adoption) situation to enable AATF quantify the impact brought by IR maize technology after adoption.

A perception study aimed at documenting the perceptions of early adopters regarding the IR maize technology and its effectiveness in controlling *Striga* was done. The perception study involved monitoring the sub-sample (400 households) of 802 households included in the AATF/IITA 2005/06 baseline survey (Manyong et al 2008). The baseline farmers had less than one year exposure in using the technology. It also included 434 households experimenting with IR maize technology served by the WeRATE consortium. Their experience with using IR maize was more than one year. The objective of the perception study was to document the level of initial adoption and the perceptions of users at the early stage of their exposure to IR maize. Specifically, the study aimed at: (1) examining the characteristics of IR maize in relation to farmer preferences; (2) assessing the performance of IR maize in terms of productivity changes, advantages and disadvantages; (3) documenting the changes in farm management practices induced by IR maize technology; and (4) assessing the adoption pathways. This was done based on the assumption that a better understanding of the farmer perceptions on the technology will identify preliminary factors that facilitate or impede adoption of IR maize at this early stage of the technology dissemination process and will help address these constraints with a view to enhancing its adoption/adaptation for greater impact on the poor rural farmers.

Methodology

Study area

The study area is Western and Nyanza provinces in the Lake zone of Kenya where maize fields are severely affected by *Striga* hence endangering the livelihood of millions of smallholder farmers. Western province covers a total area of 8,264km^2 with a population of 3,354,184 persons (as per the 1999 census) and is characterised by a high population density of 406 persons/km^2. Nyanza province covers a total area of 12,547km^2 inhabited by 4,392,196 persons (as per the 1999 census). It also has a high population density (350 persons/km^2), compared to the average of 49 persons/km^2 for the country as a whole (Republic of Kenya, 2001). These two provinces have the second and third highest population density of the country after Nairobi province. Nyanza province is divided into 12 districts, 70 divisions, 346 locations and 968 sub-locations while Western province is divided into 9 districts, 45 divisions, 204 locations and 647 sub-locations.

Sampling strategy

The selection of farmers for this study was based on having farmers who have experimented with IR maize. The sample included a subset of four 400 farmers covered during the 2005/06 baseline study. The second subset was made of 434 farmers who have been working with WeRATE. The baseline farmers were experimenting with IR maize for the first time while the WeRATE farmers had experimented with the technology for more than two seasons hence they were in a better position to give better perceptions. The choice of the two subsets was with the intention to contrast the perceptions between the two groups. Both subsets were from four districts in each province purposively chosen on the basis of high ratings of *Striga* infestation on maize and their geographic closeness in order to minimise the research cost.

Baseline farmers were selected from 16 sub-locations with the highest *Striga* infestation in the two provinces. All the villages in a chosen sub-location were listed and two villages were randomly selected; thus a total of 32 villages for the two provinces. The extension agents of the Ministry of Agriculture, known as Front-line Extension Workers

(FEWs), who had received prior special training during a methodology workshop, were tasked to make the list of all the households within each village from which they selected 25 households using random tables. This implied that each sub-location had 50 farmers interviewed during the baseline study. Out of these 50 farmers from each sub-location, 25 farmers were selected randomly from each sub-location (from a total of 16 sub-locations) to form the subset of 400 households involved in this perception study.

For the WeRATE farmers, the sample was drawn from the same districts but different divisions. Those with high *Striga* infestation and working with WeRATE were purposely selected. Two sub-locations were also purposely selected in each division. All households experimenting with IR maize in these 16 sub-locations were listed and 25 farmers randomly selected by the FEWs. In addition, two more districts, Butere/Mumias and Kakamega, were included with the intent of giving a wider coverage.

Sample size

The sample size of this study was 834 households. Ten districts were covered in the two provinces, four from Nyanza and six from Western. The four districts from Nyanza province were Bondo, Kisumu, Siaya and Nyando with 100 households from each district, hence a total of 400 households. Western province had Bungoma, Teso, Busia and Vihiga with 100 households each; Butere/Mumias with 27 households; and Kakamega with 7 households thus a total of 434 households. Baseline farmers comprised 45% of the sample while the remaining 55% were farmers who had been working with WeRATE and other research organisations.

This large sample size was necessary to get a wide variation in the perception of the IR maize technology. The geographical differences coupled with different ratings of *Striga* problem in the areas were sought to give better opinion.

Data collection and analysis

The FEWs administered structured questionnaires for household data collection. Divisional Subject Matter Specialists (DSMS) or the Divisional Agricultural Extension Officers (DAEOs) supervised FEWs in each division with backstopping from the District Agricultural Officers (DAOs), Provincial Crops Officers (PCOs) and Provincial Directors of Agriculture (PDAs). Further, IITA field technical supervisors and senior researchers were available for quality check on the data collected and for resolving any emerging challenges in their respective areas.

The questionnaire had seven main themes relating to: household characteristics; farm resource allocation; perception on *Striga* and *Striga* control technologies; IR maize productivity and farm management practices; vulnerability (livelihood strategies and outcomes); anthropometrics measurements; and GPS farm size determination. FEWs were also provided with a UNICEF bathroom weighing scale and a measuring tape for anthropometrics measurements on children aged six years and below and their mothers or immediate female guardians. A five-day methodology workshop was organised before the onset of the actual data collection to develop a common understanding of the survey. The FEWs were also trained on how to use GPS for determination of farm sizes and spatial location of farm fields. One field staff hired by IITA was stationed in the study area for smooth coordination of the data collection exercise, quality check of submitted questionnaires and responding to any emerging logistic issues.

Data analysis was done using the Statistical Package for Social Science (SPSS) computer program for both the descriptive statistics (frequency of events, means, STD) and the probit model.

The Binomial probit model

The probit model has evolved over time since Bliss (1934a/b), published two brief notes in *Science*, introducing the term probit. He followed this up with a series of articles setting out the maximum likelihood estimation of the probit curve, in one instance with assistance from RA Fisher. Bliss (1934a/b) set eight standards of estimation; until the 1930’s this was largely a matter of ad hoc numerical and graphical adjustment of curves to categorical data. Bliss (1934a/b) introduced the term *probit* (short for probability unit) originally as a convenient scale for normal deviates, but abandoned this within a year in favour of a different definition which has since been generally accepted. For any (relative) frequency (*f*) there is an equivalent normal deviate (Z) such that the cumulative normal distribution can be read from a table of the normal distribution. The articles of Bliss (1934a/b) who published regularly in this field until the 1950s aided the acceptance of the probit method.

Without the underlying theory of bio-assay, probit analysis was quickly used for any relation of a *discrete binary outcome* to one or more determinants. In economics and market research, for example, the first applications appear in the 1950’s. Farrell (1954), used a probit model for the ownership of cars of different vintage as a function of household income. Adam (1958), used the first lognormal demand curves to survey data of the willingness to buy cigarette lighters and the like at various prices. The classic monograph on the lognormal distribution of Aitchison and Brown (1957) brought probit analysis to the notice of a wider audience of economists. This was a popular tool of analysis until the introduction of the logistic as an alternative to the normal probability function.

The probit model is a popular specification of a generalised linear model (GLM) using the probit link function. GLM is a useful generalisation of ordinary least squares regression. Most generalised linear models have three components: a distribution function (*f*) from the exponential family, a linear predictor ($\eta = X\beta$) and a link function (g) such that $E(y) = \mu = g^{-1}(\eta)$. It stipulates that the random part of the experiment (the *distribution function*) and the systematic portion of the experiment (the *linear predictor*) are related by a function called the *link function*. In a GLM, the data (Y) is assumed to be generated from a distribution function in the exponential family (a very large range of distributions). The data's expected value (μ) is predicted by:

$$E(Y) = \mu = g^{-1}(X\beta),$$

where: $X\beta$ is the *linear predictor*, a linear combination (X) known from the experiment of unknown parameters (β), and g is called the *link function*.

In this framework, typically the random component is also a function (V) of the mean:

$$\mathrm{Var}(Y) = V(\mu) = V(g^{-1}(X\beta)).$$

It is convenient if the variance follows from the exponential family distribution, but it may simply be that the variance is a function of the predicted value. The unknown parameters (β) are typically estimated with maximum likelihood, quasi-maximum likelihood or Bayesian techniques.

The probit function is the inverse cumulative distribution function or quintile function of the normal distribution. The probit function is often denoted as Φ^{-1} and is of type:

$$\Phi^{-1} : [0;1] \Rightarrow (-\infty; +\infty).$$

Like the logit (log odds) function, it may be used to transform a variable (p) ranging over the interval [0, 1] into a derived quantity $\Phi^{-1}(p)$ ranging over the real numbers. This has applications in probit models, which are generalised linear models. The probit function may be expressed in terms of the inverse of the error function:

$$\Phi^{-1}(p) = \sqrt{2}\,\mathrm{erf}^{-1}(2p - 1).$$

Because the response is a series of binomial results, the likelihood is often assumed to follow the binomial. Let Y be a binary outcome variable, and let X be a vector of regressors. The probit model assumes that:

$$\Pr(Y = 1 \mid X = x) = \Phi(x'\beta),$$

where: Φ is the cumulative distribution function of the standard normal distribution. The parameter β is typically estimated by maximum likelihood.

The probit model can be obtained from a simple latent variable model. Suppose that:

$$Y^* = x'\beta + \varepsilon,$$

where: $\varepsilon \mid x \sim N(0,1)$, and suppose that Y is an indicator for whether the latent variable Y^* is positive:

$$Y \overset{\text{def}}{=} 1_{(Y^*>0)} = \begin{cases} 1 & \text{if } \; Y^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

then it is easy to show that:

$$\Pr(Y = 1 \mid X = x) = \Phi(x'\beta).$$

For this study, the empirical model included variables that were hypothesised to strongly affect perceptions on IR maize on the basis of both theoretical and empirical works in the areas of technology perceptions and adoptions. These entailed two sides of perceptions, IR maize as a variety and as a technological package with its guidelines. With ordinal and nominal outcomes from the following attributes/performance factors, the dependent variable was created out of the farmers' overall perception of IR maize. There were three outcomes on the farmer perceptions of the technology, namely highly appropriate, intermediate and not appropriate. The first outcome (highly appropriate) forms Category 1 in the equation below and the last two outcomes (intermediate and not appropriate) form Category 0 for this case:

$$Y \overset{\text{def}}{=} 1_{(Y^*>0)} = \begin{cases} 1 & \text{if } \; Y^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

The independent variables in the empirical model were made of two categories of factors: ordinal and nominal independent variables.

Ordinal independent variables included farmers' ranking of IR maize as a variety or a technological package on many parameters such as ability to enhance maize yield, technical simplicity, management cost, ability to reduce *Striga* population, soil fertility enhancement, vegetative vigour, ability to withstand other abiotic stresses such as drought, ability to withstand biotic factors such as pests and diseases, group membership (whether a household member belongs to a group or not), gender of household head, sharing of information with other farmers, food shortage experienced by the household, attendance of training on IR maize, baseline or non-baseline farmer, and location in Western or Nyanza province. Drawing from previous work done in western Kenya, it was hypothesised that Nyanza province farmers would have a more positive perception on the IR maize technology based on the fact that this would be the first time they use the technology. It was further hypothesised that WeRATE farmers would have a higher positive perception of the technology based on the fact that they had been introduced to the technology for a longer period of time. Gender (female = 0 and male = 1) and group membership were also hypothesised to affect positively the perception. Except farmer perceptions on the management cost of the technology that had an expected negative relationship, the perception on other technology characteristics were hypothesised to have a positive relationship with the dependent variable because they are expected to influence positively the farmer perceptions of the technology. Food shortage was hypothesised to have a positive relationship as households were expected to grab any new technology to get out of the food insecurity.

Nominal independent variables included yield of IR maize as perceived by farmers and actual yields of maize (local, hybrid and IR maize) in sole or intercropping, number of extension visits per year on improved maize variety, income from maize, age of respondent, years since adoption of the technology, number of years of schooling for the respondent, and size of land farmer has access to.

Age and education of the respondent are important human capital variables that evaluate the ability of the farmer to understand the various guidelines that accompany new technologies. The hypothesised relation was positive with the positive perception of the technology. The number of years since adoption and maize income were expected to also have a positive relationship with the dependent variable. High yield from IR maize (as perceived or actual, sole or intercropped) was expected to exert a positive perception while that of local maize or hybrid maize would inhibit the positive perception on IR maize as a technology and as a package.

The factors with probability of less than 5% had higher impact to perception thus as the value fell to zero the factors were considered to have affected more on the perception of IR maize. The coefficients (+ve and –ve) explain the hypothesis in the weights given.

The list of all the independent variables appear in Appendix 1.

Outline of the report

This report is divided into eight chapters. Chapter 2 describes the household characteristics and sources of income to the households. Household farm resources and input use are discussed in Chapter 3, while *Striga* and *Striga* control approaches are discussed in Chapter 4. Chapter 5 discusses the productivity, farm management practices and perceptions of IR maize. Chapter 6 discusses the food security and nutrition status in the Lake zone of Kenya while Chapter 7 describes the government and Non-Governmental Organisations (NGOs) roles and involvements in western Kenya. Chapter 8 gives the conclusions and recommendations to the study.

Chapter 2

Socio-economic characteristics of the households

Demographic and socio-economic characteristics of households

Most households (about 76%) in the study areas were headed by males, a typical household heading characteristic of most countries situated in Sub-Saharan Africa (Table 2.1). Inter-province differences in household headship showed that more female-headed households were found in Nyanza province (28%) than in Western province (19.59%). This can be explained possibly by the high mobility of men in Nyanza than those in Western and the high incidence of HIV/AIDs in Nyanza compared to Western.

Table 2.1. Household characteristics

Household attributes	All		Nyanza		Western	
	N		N		N	
Male household head (%)	834	76.26	400	71.75	434	80.41
Age of household head (years)	828	51.07	396	51.86	432	50.35
Years of schooling of head	834	4.73	400	4.21	434	5.21
Age of respondent	828	49.54	396	50.37	432	48.79
Years of schooling for respondent	828	3.94	400	3.53	434	4.32

N = Number of respondents

The average age of heads of households from both provinces was 51 years. The inter-province difference in average age of households was very small.

The average number of years of schooling of heads of households in both provinces was low (about five years) though a bit higher in Western province. At this level of education, most heads of households could read and write in Kiswahili, which is an essential attribute for adoption of technologies.

The average age for respondents was slightly lower than the average age of heads of households. However, the difference was quite high for years of schooling between respondents and heads of households. The reason could be that most of respondents were wives of heads of households who are more disadvantaged in education.

Social capital

Members in farming communities rely on each other for material and moral support as well as sharing of ideas on farming. It is also easier to access new technologies and other support services as organised groups rather than as individuals. It is also common to find strong social groups where official government service provision is weak or unavailable. In about 83% of households, respondents or members of the households were members of community groups or associations (Table 2.2). It was as well evident that some respondents belonged to only one group while others belonged to more than one group (Table 2.3). The results also point to the fact that more WeRATE farmers (93%) belonged to groups as compared to only 70% of the baseline farmers. This scenario was also true for farmers from Nyanza where about 87% of the respondents belonged to groups compared to 79% from Western.

Table 2.2. Households group membership

Group membership	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
Belong to group (%)	82.61	69.68	93.23	86.75	78.80
Does not belong to group (%)	17.39	30.32	6.77	13.25	21.20

N = Number of respondents

Table 2.3. Households group membership intensity

	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
Number of groups belonging to:	%	%	%	%	%
None	17.39	30.32	6.77	13.25	21.20
One	41.97	51.06	34.50	49.5	35.02
Two	28.66	12.50	41.92	27.25	29.95
Three	7.31	4.52	9.61	7.00	7.60
Four	2.76	1.06	4.15	1.75	3.69
Five	1.44	0.53	2.18	1.25	1.61
Six	0.24	0	0.44	0	0.46
Seven	0.24	0	0.44	0	0.46

N = Number of respondents

Generally, a large number (42%) belong to at least one group or two groups (29%). As the number of groups increases the percentage of farmers belonging to multiple groups reduces. A look at the two groups of farmers (baseline and WeRATE) revealed an interesting trend. Most baseline farmers (51%) belonged to one group, and the maximum number of groups any household members were involved in was five. More WeRATE farmers (43%) belonged to two groups as compared to only (35%) who belonged to one group. It was also evident that the WeRATE farmers had a tendency to belong to many groups in some cases belonging to as many as seven. There were minimal differences in terms of the number of groups farmers belonged to in both Western and Nyanza provinces. More farmers from both provinces belonged to one group. No farmers from Nyanza belonged to more than five groups contrary to those from Western province who belonged to as many as seven groups.

The results from the analysis of the types of groups common in western Kenya reveal that most of the respondents belonged to women groups (35%), community development (28%) and religious groups (24%).

Table 2.4. Types of groups/associations

Type of group/association	Frequency (Percentage)
Community development	27.50
Cooperative	3.78
Religious group	23.63
Credit and savings group	5.63
Informal insurance (safety net)	1.43
AIDS group	1.77
Women's group	35.24
Youth group	0.08
Widow's group	0.17

Human capital

It is common knowledge that household labour endowment is important for adoption of new technologies more so where they require more labour input. Equally important in technological adoption is the level of education of the household heads and the members in general. Higher education has been associated with higher possibilities of adopting new technologies. This is also important in terms of interpreting the guidelines that often accompany the new technologies.

The other important parameter with regard to human capital is the extension services. Both government and private extension services help farmers access new technologies and demonstrations on how to apply the various guidelines related to a new technology. In addition, extension providers play an important role in monitoring and evaluation of these new technologies. This study looked at the number of visits farmers had received from the extension service providers as well as the farmers' participation in field days, seminars and agricultural shows (Table 2.5).

Table 2.5. Extension visits

Extension visits	All	Baseline	WeRATE	Nyanza	Western
Extension visits (%)	89.0 (747)	95.4 (328)	84.0 (419)	90.5 (337)	87.8 (410)
Attend field days/seminars/ agricultural shows (%)	67.9 (834)	55.6 (376)	77.9 (458)	63.8 (400)	71.7 (434)

Figures in brackets indicate the number of respondents

Eighty nine percent (89%) of the respondents indicated that extension agents had visited them at least once and 68% had attended seminars, field days or agricultural shows in 2005 (Table 2.5). It was also evident that more baseline farmers (95%) were visited by the extension agents compared to the WeRATE farmers (84%). It is also clear from the results that more WeRATE farmers (78%) attended seminars, field days or agricultural shows. Extension services were stronger in Nyanza province as compared to Western province. The reverse was however true for field days, seminars and agricultural shows where more farmers (72%) from Western province benefited compared to 64% from Nyanza province.

About 56% of the respondents pointed out that they received between 1 and 5 visits in 2005, 5% received between 6 and 10 visits, and 4% received more than 10 visits in the same year (Table 2.6). WeRATE farmers received more frequent visits than the baseline farmers did, which was also true for Western province farmers compared to Nyanza province farmers. This differs from the number who received at least one visit. The implication here is that the extension agents tend to visit the same farmers more frequently rather than visit as many farmers as possible.

Table 2.6. Intensity of extension visits in 2005

Number of visits	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
None	35.5	42.8	29.5	46.5	25.3
1–5	55.9	52.7	58.5	49.5	61.8
6–10	4.6	3.2	5.7	2.8	6.2
Above 10	4.1	1.3	6.3	1.3	6.7

N = Number of respondents

Sources of income to households

Apart from farming providing food for most households, some of these food crops are sold for cash. Maize, sorghum, beans, groundnuts, vegetables, tobacco, sweet potatoes, tomatoes, bananas, cotton and rice are important in terms of income generation to the households as demonstrated in Table 2.7.

Table 2.7. Household income from various crops in 2005

	All		Baseline		WeRATE		Nyanza		Western	
Crop	N	Ksh	N	Ksh	N	Ksh	N	Ksh	N	Ksh
Maize	808	5,183	358	3,761	450	6,314	379	4,225	429	6,029
Sorghum	279	2,070	168	2,193	111	1,884	208	2,248	71	1,548
Beans	427	2,448	165	1,831	262	2,837	170	1,813	257	2,868
Groundnuts	79	3,264	27	4,281	52	2, 736	42	3,992	37	2,437
Vegetables	68	5,724	15	7,013	62	6,245	25	10,180	43	3,131
Sweet potatoes	101	3,262	45	2,056	56	4,231	43	2,470	58	3,849
Fruits	59	2,785	24	3,596	35	2,229	14	2,071	45	3,007
Cassava	154	3,677	78	3,014	76	4,358	32	2,831	122	3,899
Cowpea	18	629	15	633	3	613	17	631	1	600
Green grams	26	1,120	21	992	5	1,655	24	1,074	2	1,670
Rice	7	17,943	7	17,943	0	–	7	17,943	0	–
Tomatoes	10	7,825	2	12,500	8	6,656	5	10,340	7	2,600
Arrow roots	2	7,500	1	8,000	1	7,000	3	3,333	7	9,750
Cotton	2	9,500	2	9,500	0	–	1	8,000	1	7,000
Finger millet	40	2,108	10	2,550	30	1,961	2	9,500	0	–
Chewing cane	4	13,125	0	–	4	13,125	0	–	40	2,108
Blue gum trees	2	25,500	0	–	2	25,500	0	–	4	13,125
Tobacco	12	21,667	7	16,000	5	29,600	0	–	2	25,500
Soybeans	16	1,872	0	–	16	1,872	0	–	12	21,667
Fodder	9	13,189	0	–	9	13,189	2	1,275	14	1,957
Bananas	35	2,976	4	2,300	31	3,063	6	18,700	3	2,167
Onions	2	5,500	0	–	2	5,500	6	3,700	29	2,826
Tree seedlings	1	900	0	–	1	900	1	4,000	1	7,000
Sunflower	1	7,200	0	–	1	7,200	0	–	1	900
Coffee	1	2,000	0	–	1	2,000	1	7,200	0	–

N = Number of respondents

The other income sources that were equally important include income from other farm enterprises, off farm activities (less than 50% of households), remittance from relatives (about 25% of households), credit both formal and informal (about 10% of households) and spouse's salaries (Table 2.8).

Table 2.8. Household income from non-farm sources in 2005

Income from non-farm sources	All		Baseline		WeRATE		Nyanza		Western	
	N	Ksh	N	Ksh	N	Ksh	N	Ksh	N	Ksh
Other farm enterprise (livestock, beekeeping)	236	7,746	88	5,288	148	9,209	109	6,451	127	8,859
Off-farm (petty trade, basketry, blacksmith, sale of labour, wage)	339	9,070	176	8,684	163	9,488	174	10,525	165	7,537
Remittances from relatives	207	4,534	106	3,408	101	5,715	108	3,796	99	5,339
Credit (formal and informal)	83	7,505	54	8,327	29	5,974	45	7,777	38	7,184
Spouse's salary	22	33,033	14	35,301	8	29,063	17	29,366	5	45,500

N = Number of respondents

The other important parameter about the sources of income was the proportion of income from maize. Maize contributed about 35% of the total income to households. This strengthens the importance of maize in western Kenya. WeRATE farmers indicated that maize formed 37% of their total household income compared to 32% for the baseline farmers. Farmers in Western and Nyanza provinces pointed out that maize contributed 35% to the total incomes of their households (Table 2.9). There is quite a large variability in the proportion of income as shown by the standard deviation.

Table 2.9. Proportion of income from maize in 2005

	N	(%)	SD (%)
All	818	34.86	23.03
Baseline	368	32.27	23.17
WeRATE	450	36.99	22.72
Nyanza	385	34.61	24.90
Western	433	35.09	21.26

N = Number of respondents; SD = Standard Deviation

Chapter 3
Household farm resources and productivity

Land allocation to crops/cropping systems

Farm size (ha) determination

Miniature landholding has been categorised several times as one of the bottlenecks of land productivity in western Kenya. Small land holding leads to very low maize production. Farm size was determined first using farmers' memory recall (Table 3.1). The average land from 834 households in Western and Nyanza provinces was about 1.25ha/household and it was higher among WeRATE farmers (1.27ha/household) than baseline farmers (1.22ha/household). Western province farmers had higher access to land (1.31ha/household from 434 households) compared to farmers in Nyanza province (1.18ha/household out of 400 households).

Table 3.1. Farm size (ha) determination: Farmers' memory recall

Farm sizes	All		Baseline		WeRATE		Nyanza		Western	
	N	ha	N	ha	N	ha	N	ha	N	ha
Total land access	834	1.25	376	1.22	458	1.27	400	1.18	434	1.31
IR maize sole	422	0.07	224	0.08	198	0.07	267	0.08	155	0.07
IR maize intercropped	330	0.07	155	0.07	175	0.08	93	0.08	237	0.07
Local maize sole	187	0.27	65	0.35	122	0.23	130	0.27	57	0.26
Local maize intercropped	442	0.31	220	0.32	222	0.31	218	0.35	224	0.27
Hybrid maize sole	105	0.27	24	0.35	81	0.24	46	0.22	59	0.30
Hybrid maize intercropped	223	0.41	76	0.62	147	0.31	61	0.31	162	0.45
Total land under maize cropping system (ha)		1.09		1.16		0.93		1.03		1.1
Proportion of land under maize cropping system over total land (%)		87.20		95.08		73.23		87.29		83.97

N = Number of respondents

Farm size determination based on farmers' memory recall indicates that more than 75% of land was allocated to maize cropping systems. About land allocation to various maize varieties, farmers in Nyanza had more land (0.08ha/household) under IR maize sole compared to those from Western province who had 0.07ha/household under IR maize sole. Baseline farmers in both provinces had an average land of 0.008ha/household planted to IR maize sole, while WeRATE farmers had 0.07ha/household on the same cropping system. WeRATE farmers, however, had higher land (0.08ha/household) planted to IR maize intercropped compared to 0.07ha/household by baseline farmers on the same cropping type. Results in Table 3.1 also show that households from Nyanza had more land (0.08ha/household) under IR maize intercropped compared to 0.07ha/household for farmers from Western.

Overall land usage for local varieties was close under sole maize and intercropped with other crops in both provinces. The same pattern was observed for baseline farmers. Differences were noticed for WeRATE farmers who had 0.23ha/household under local maize sole and 0.31ha/household for local maize intercropped. Area under local maize sole cropping type was at all times lower in both provinces (0.27ha/household for Nyanza and 0.26ha/household for Western) than land under local maize intercropped system (0.35ha/household and 0.27ha/household in Nyanza and Western provinces respectively). For hybrid maize, the average land under sole and intercropped was 0.27ha/household and 0.41ha/household in Nyanza and Western provinces respectively. Average land accessed by baseline farmers under hybrid maize sole type of cropping was 0.35ha/household and 0.62ha/household for hybrid maize intercropped. This was different from 0.24ha/household and 0.31ha/household for WeRATE farmers in the same accounts. Land cultivated to hybrid maize shows Nyanza province had 0.22ha/household and 0.31ha/household under sole cropping and intercropping respectively, compared to 0.30ha/household and 0.45ha/household in Western province.

Generally, farmers adopt intercropping as a risk minimisation strategy through the diversification of crops on the same piece of land. In a less capital intensive system, diversification has been found to be an efficient strategy to optimise the use of natural resources on a small piece of land.

Farm size (ha) determination: GPS measurement

It is believed that farmers have the ability to remember the size of the land they hold and/or access. However, their overestimation or underestimation of land size cannot be denied. Overestimation or underestimation of land size can be due to very large or miniature size of land they hold and/or access and in some cases farmers will simply not tell the truth about the size of land they own or access. Consequently, it becomes difficult to estimate land productivity and suggest appropriate production measures. GPS measurements to various maize cropping systems was carried out to compare findings from farmers' memory recall and those from modern science in land size determination.

The difference in the land sizes as measured by the two approaches was quite important. Results in Tables 3.1 and 3.2 show that land size values under all maize cropping systems were higher for land size determined by farmers' memory recall

Table 3.2. Farm size (ha) determination: GPS measurement

Farm sizes	All			Baseline			WeRATE			Nyanza			Western		
	N	Mean (ha)	SD	N	Mean (ha)	SD	N	Mean (ha)	SD	N	Mean (ha)	SD	N	Mean (ha)	SD
Total land access*	834	1.25	2.96	376	1.22	2.85	458	1.27	3.05	400	1.18	2.55	434	1.31	3.29
IR maize sole	420	0.04	0.09	217	0.04	0.09	203	0.04	0.08	266	0.04	0.10	154	0.03	0.06
IR maize intercropped	335	0.05	0.13	159	0.04	0.09	176	0.05	0.16	95	0.05	0.14	240	0.05	0.13
Local maize sole	192	0.14	0.41	69	0.17	0.46	123	0.12	0.38	135	0.15	0.40	57	0.12	0.45
Local maize intercropped	451	0.14	0.38	225	0.15	0.37	226	0.14	0.40	225	0.17	0.44	226	0.12	0.31
Hybrid maize sole	97	0.15	0.32	23	0.15	0.34	74	0.15	0.32	43	0.13	0.32	54	0.17	0.32
Hybrid maize intercropped	230	0.22	0.64	75	0.30	0.82	155	0.19	0.51	56	0.18	0.52	174	0.24	0.67
Total land under maize cropping (ha)			0.58			0.69			0.52			0.57			0.56
Proportion of land under maize cropping system over total land (%)			46			57			41			48			43
Proportion of intercropped maize (%)			70.69			71.01			73.08			70.18			73.21

N = Number of respondents; SD = Standard deviation; * = Same land size values obtained from farmers' memory recall compared to the GPS determined. Overall, land measured using GPS was 53.21% the size of land recorded from farmers' memory recall. The same results (59.48%) were relatively better for baseline farmers compared to WeRATE farmers (55.91%), and so for Nyanza farmers (55.34%) compared to Western farmers (50.91%). This shows what farmers perceive and the real situation on the ground. Standard deviations were at all times higher for hybrid maize intercropped and least for IR maize sole and intercropped. Generally, maize intercropped systems registered higher standard deviations than was the case with maize sole cropped systems. It is also evident that the standard deviations are lower in the GPS system than the farmers' memory recall approach. This elucidates the positive effect of modern science, which reduces the error in determination of land sizes. The effect of such an approach trickles all the way to appropriate policy intervention proposals and equip extension services with modern tools in the implementation of their daily tasks. Results from the GPS measurements also show the importance of maize cropping systems in the study area.

Intensification of maize farming systems

Inputs received through the IR maize kit for the 2006 long rains

The use of farm inputs bought from stockists or supplied by NGOs and other agricultural support programmes is common practice among farmers in the Lake zone of Kenya. The IR maize kit included maize seed, inorganic fertiliser, and extension messages as to the use of the kit. The use of farm inputs during the 2006 long rains in Table 3.3 shows that 753 households in both provinces received an average of 1.2kg/household of IR maize seed, that is an average of 1kg and 1.3kg of IR maize seed per household in Nyanza and Western provinces respectively. Despite the fact that baseline farmers had just started accessing IR maize seed, results for 2006 long rains show that they received an average of 1kg of IR maize slightly lower than the amount received by the WeRATE farmers who received an average of 1.4kg per household. Farmers in both categories also received inorganic fertilisers during the 2006 long rains. Total average amount of inorganic fertiliser received during the 2006 long rains in both provinces was about 2kg/household (Table 3.3).

Table 3.3. Inputs received by farmers through the IR maize kit for the 2006 long rains

Input	All		Baseline		WeRATE		Nyanza		Western	
	N	kg	N	kg	N	kg	N	kg	N	kg
IR maize seed received	753	1.22	376	1.04	377	1.39	359	1.10	394	1.32
Chemical fertiliser received	649	1.87	376	1.87	273	1.86	310	1.88	339	1.86

N = Number of respondents

The results in Table 3.3 show that while 93% of farmers received the seed, only 78% got the accompanying inorganic fertiliser.

Fertilisers and pesticides utilisation

Farmers in western Kenya commonly used three types of fertilisers during the 2006 long rains, which were DAP, UREA and CAN. Intercropped maize seemed to enjoy a higher use of fertiliser/manure inputs at all times than sole stand cropping systems during the 2006 long rains as can be seen from Tables 3.4 and 3.5.

The study results reveal that only a few farmers invested in inorganic fertilisers in western Kenya. This can be seen from the low levels of fertiliser applications on the farms. In all cases, farmers applied inorganic fertiliser below the recommended levels of at least 90kg to 120kg N/ha for optimal productivity. Farmers applied about one 50kg bag per hectare for IR maize sole while the rates were higher for IR maize intercropped (85kg/ha). Hybrid intercropped received more attention in terms of fertiliser (170kg/ha). Local maize varieties were grown with almost negligible amounts of inorganic fertiliser. This could either be because the local varieties are hardy and can still do well without fertiliser or that they are not so important to the farmers. The WeRATE farmers applied more inorganic fertiliser on their maize plots than the baseline farmers in all variations of cropping systems. This was also true for farmers in Western province compared to their counterparts in Nyanza province.

Table 3.4. Inorganic fertiliser use for the 2006 long rains

	All		Baseline		WeRATE		Nyanza		Western	
Maize cropping systems	N	kg/ha	N	kg/ha	N	kg/ha	N	kg/ha	N	kg/ha
IR maize sole	422	52.75	224.00	54.25	198	51.50	267	47.75	155	82.00
IR maize intercropped	330	85.60	155.00	82.00	175	103.60	93	87.40	237	85.20
Local maize sole	187	0.93	65.00	16.29	122	25.17	130	18.67	57	26.92
Local maize intercropped	442	23.71	220.00	19.47	222	26.50	218	5.18	224	47.50
Hybrid maize sole	105	81.33	24.00	48.60	81	90.93	46	55.92	59	94.29
Hybrid maize intercropped	223	171.95	76.00	59.07	147	172.21	61	132.78	162	145.50

N = Number of respondents

The use of manure and compost fertilisers was common in the study area. This can be seen from the large quantities applied to various maize cropping systems. All maize plots received more than 300kg/ha of manure during the 2006 long rains planting season. IR maize intercropped received the highest share of manure from 700kg/ha to over 1,000kg/ha. It is also evident from the results in Table 3.5 that WeRATE farmers utilised more manure and compost fertilisers than the baseline farmers. This can be attributed to their exposure to better crop husbandry practices. It is also observable that farmers in Nyanza province applied more manure on their maize plots as compared to farmers in Western province. It can be concluded from Tables 3.4 and 3.5 that the relationship between inorganic fertiliser application and manure application on maize plots is inversely related. It is evident that in plots where farmers applied more manure they applied less inorganic fertiliser probably because of the high cost of inorganic fertiliser. The alternative explanation would be that as much as farmers apply organic fertiliser, they still believe that their maize would do better by addition of small quantities of inorganic fertiliser particularly during the top dressing, a common practice among maize farming communities.

Table 3.5. Organic fertiliser use for the 2006 long rains

Maize cropping systems	All		Baseline		WeRATE		Nyanza		Western	
	N	kg/ha	N	kg/ha	N	kg/ha	N	kg/ha	N	kg/ha
IR maize sole	422	351.50	224	386.25	198	312.25	267	434.50	155	278.00
IR maize intercropped	330	1,099.60	155	739.75	175	1,549.20	93	1,941.20	237	769.20
Local maize sole	187	353.57	65	135.76	122	529.75	130	290.53	57	524.83
Local maize intercropped	442	687.86	220	372.40	222	974.14	218	484.47	224	915.58
Hybrid maize sole	105	595.33	24	1,438.87	81	345.33	46	1,435.77	59	78.76
Hybrid maize intercropped	223	687.73	76	504.83	147	795.89	61	550.11	162	712.46

N = Number of respondents

The use of pesticides was rarely witnessed because pesticides are largely used for post harvest activities before storage while the study was carried out when the crop was still on the farms.

Seed use

Quantities of maize seed used by farmers often vary from those recommended by the extension service providers. For IR maize the average seed quantity per hectare was 27 kilogrammes, that is 2kg above the recommended 25kg/ha. The worst situation was for the local maize where farmers put in more than 35kg/ha. It is evident farmers over apply or under apply maize seeds for all varieties. This leads to non optimal crop density. The consequence of such management practices is low productivity of maize. There is every need that farmers adhere to the recommended quantities per area for maximum nutrient utilisation and optimum production from such areas.

It can be deduced from Table 3.6 that farmers in western Kenya still need more push on right crop husbandry especially on issues related to spacing and the proper number of maize seeds per hole for the purpose of realising high crop productivity per given piece of land. Such a high number of seeds per area than recommended rates reveal the fact that farmers tend to put more seeds per hole for fear that some seeds will die before germination or at any growth stage; or having many seeds per hole means high yields while in fact the reverse is true. Incidences of pests and diseases as well as weather stress also lead many poor farming households to this attitude. Such farmers perceive that the effects of pests and diseases will cause some seeds not to germinate or to die early after germination. In an effort to minimise the risks, farmers plant many seeds per hole hoping a few will survive to maturity.

Table 3.6. Maize seed use for the 2006 long rains

	All		Baseline		WeRATE		Nyanza		Western	
Maize cropping systems	N	kg/ha	N	kg/ha	N	kg/ha	N	kg/ha	N	kg/ha
IR maize sole	422	27.75	224	25.50	198	30.25	267	26.00	155	41.00
IR maize intercropped	330	27.60	155	28.00	175	32.20	93	27.60	237	27.60
Local maize sole	187	35.57	65	37.59	122	35.17	130	34.07	57	38.92
Local maize intercropped	442	36.64	220	34.73	222	36.07	218	32.82	224	39.17
Hybrid maize sole	105	30.33	24	35.13	81	28.93	46	28.46	59	30.65
Hybrid maize intercropped	223	34.00	76	29.83	147	35.37	61	33.56	162	33.42

N = Number of respondents

Chapter 4
Striga and *Striga* control technologies

Striga control technologies

Striga infestation is a major threat to livelihoods of most poor rural farmers who depend on maize production in western Kenya. There are several traditional and conventional or modern *Striga* control methods. In the traditional methods, the farmers uproot the *Striga* weeds on the farms once they emerge above the soil level, some burn the *Striga* weed once it is dry after uprooting while others use manuring in which case they improve the soil fertility to reduce the adverse effects of the weed on the maize. The most important modern technologies are *Striga* tolerant improved maize varieties of KSTP94 and WS909 developed by the Kenya Agricultural Research Institute (KARI), intercropping of legumes followed by cassava/Desmodium, maize/Desmodium strip cropping (known as the push-pull technology developed by the International Centre of Insect Physiology and Ecology), and IR maize (developed by CIMMYT).

Awareness of *Striga* control technologies

All the sampled farmers were aware of IR maize technology (Table 4.1). This result was expected because all the farmers involved in the perception study on IR maize technology were those who had experience with the maize variety. The traditional methods of *Striga* control were also the most common. The results show that more than 99% of all the respondents were aware of the traditional methods of *Striga* control. It is also evident that farmers in Nyanza province are more aware of the traditional *Striga* control methods than their counterparts in Western province. This would be due to the greater effects of *Striga* in Nyanza province than in Western province.

Table 4.1. Awareness of *Striga* control technologies

Striga control technologies	All (834)	Baseline (376)	WeRATE (458)	Nyanza (400)	Western (434)
IR maize variety (*Ua Kayongo*)	100.0	100.0	100.0	100.0	100.0
Striga tolerant maize KSTP94 (with legumes)	9.83	0.5	17.5	8.3	11.3
Striga tolerant maize WS909 (with legumes)	17.39	8	25.1	15.3	19.4
Intercropping of legumes followed by cassava/ Desmodium	10.8	3.5	16.8	12.5	9.3
Push-pull (maize/Desmodium strip cropping)	19.2	1.9	33.4	15.8	22.8
Traditional practices (manuring, uprooting, burning)	99.5	99.7	99.3	100.0	99.1

Figures in brackets indicate the number of respondents

A study conducted in 2005 (Manyong et al, 2006) showed that less than 5% of households were not aware of modern *Striga* control technologies. The results from this study show that farmers in western Kenya are slowly getting more and more informed. Push-pull and *Striga* tolerant WS909 are *Striga* control methods that are gaining popularity in the study region. It is worth noting, however, that WeRATE farmers were found to be more aware of these modern methods compared to baseline farmers. This is because of numerous campaigns spearheaded by the NGOs, research organisations and seed companies working in the area. There is no major difference in the number of households aware of the technologies in Western and Nyanza provinces.

Current use status of *Striga* control technologies

With a slight improvement in the awareness of the technologies, there is a matched improvement in the current usage of the technologies. The results reveal that though the farmers have been introduced to modern *Striga* control technologies, most of them (94%) are still using the traditional practices to control *Striga*. More than 91% of the households were using the IR maize technology to combat *Striga* in the region. From the data collection framework, it was expected that the current IR maize use status was to be 100% since all farmers included in the study were perceived to have been provided with IR maize seed. It was, however, observed in the field that some farmers received the IR maize seed kit very late and could therefore not plant. Others who were supposed to get the kit did not receive it due to distribution and other logistical problems. At least more than 20% of the households were using *Striga* tolerant KSTP94 and WS909 as well as intercropping of legumes followed by cassava/Desmodium and push-pull in controlling *Striga* on their farms. It is also evident that most of the farmers who were aware of these technologies fell under the WeRATE group, probably because of good technical advice received from NGOs. Alene et al (2006) show that farmers easily adopt seed varieties but find it difficult to modernise their crop management practices.

Table 4.2. Current use status of *Striga* control technologies (% households)

		All			
***Striga* control technologies**	N	1*	2*	3*	4*
IR maize variety (*Ua Kayongo*)	834	91.5	8.5	–	–
Striga tolerant maize KSTP94 (with legumes)	82	20.7	18.3	61.0	–
Striga tolerant maize WS909 (with legumes)	147	30.6	16.3	53.1	–
Intercropping of legumes followed by cassava/Desmodium	90	36.7	8.9	54.4	–
Push-pull (maize/Desmodium strip cropping)	160	27.5	9.4	63.1	–
Traditional practices (manuring, uprooting, burning)	830	94.3	3.0	2.0	0.7

N = Number of respondents

1* Currently using; 2* Abandoned; 3* Never adopted; 4* No *Striga* on farm

Table 4.2 shows that a good proportion of farmers (>30%) were using other *Striga* control technologies, and almost all (94.5%) still use traditional methods such as manuring, uprooting and burning. This means that farmers are experimenting with many options of *Striga* control at the same time. This is partly due to the fact that the IR maize seed supplied could only cover a 20 × 20 metre square area, leaving much of the land the farmers have free for planting with other maize varieties. In some other cases, and more particularly where the WeRATE group of researchers and NGOs were working, the farmers were experimenting with different *Striga* control technologies. Though such a situation poses a difficulty in singling out the effectiveness of a certain technology, it gives the farmers a better perception on the effectiveness of the various options. As previously stated, intercropping is the rampant cropping system in the two provinces. This means that despite having diminutive plots, farmers can in the same plot plant IR maize seed, KSTP94 and/or WS909 and continue suppressing emerging *Striga* using traditional practices at the same time. Such a situation may however call for establishment of controlled plots where each technology is applied in isolation plots and apportion other plots under multiple *Striga* control technologies.

In general, the use of modern technologies was popular among the baseline farmers and in Nyanza province compared to the other groups (Tables 4.3 and 4.4). A small number of farmers introduced to various technologies aimed at controlling *Striga* had abandoned them. For instance 15.5% of WeRATE farmers declared they had abandoned the use of IR maize technology because of lack of inputs during the 2006 long rains.

Table 4.3. Baseline vs WeRATE farmers current use status of *Striga* control technologies (% households)

***Striga* control technologies**	Baseline					WeRATE				
	N	1*	2*	3*	4*	N	1*	2*	3*	4*
IR maize variety (*Ua Kayongo*)	376	100.0	–	–	–	458	84.5	15.5	–	–
Striga tolerant maize KSTP94 (with legumes)	2	50.0	50.0	–	–	80	21.3	17.5	61.3	–
Striga tolerant maize WS909 (with legumes)	30	20.0	33.3	46.7	–	117	33.3	12.0	54.7	–
Intercropping of legumes followed by cassava/ Desmodium	13	61.5	7.7	30.8	–	77	32.5	9.1	58.4	–
Push-pull (maize/ Desmodium strip cropping)	7	–	14.3	85.7	–	153	28.8	9.2	62.1	–
Traditional practices (manuring, uprooting, burning)	375	93.9	3.7	1.9	0.5	455	94.5	2.4	2.2	0.9

N = Number of respondents

1* Currently using; 2* Abandoned; 3* Never adopted; 4* No *Striga* on farm

This was more important given the fact that the IR maize variety was not available in the market at the time of the survey. The largest abandonment was recorded for KSTP94 by baseline farmers (50%) and the lowest for the traditional methods by WeRATE farmers (2.4%).

Table 4.4. Nyanza/Western province farmers current use status of *Striga* control technologies (% households)

	Nyanza					Western				
***Striga* control technologies**	N	1*	2*	3*	4*	N	1*	2*	3*	4*
IR maize variety (*Ua Kayongo*)	400	90.5	9.5	0	0	434	92.4	7.6	0	0
Striga tolerant maize KSTP94 (with legumes)	33	15.2	24.2	60.6	0	49	24.5	14.3	61.2	0
Striga tolerant maize WS909 (with legumes)	63	30.2	14.3	55.6	0	84	31.0	17.9	51.2	0
Intercropping of legumes followed by cassava/ Desmodium	50	52.0	10.0	38.0	0	40	17.5	7.5	75.0	0
Push-pull (maize/Desmodium strip cropping)	63	33.3	11.1	55.6	0	97	23.7	8.2	68.0	0
Traditional practices (manuring, uprooting, burning)	400	93.5	4.0	1.8	0.8	430	94.9	2.1	2.3	0.7

N = Number of respondents

1* Currently using; 2* Abandoned; 3* Never adopted; 4* No *Striga* on farm

The results also show in general that the proportion was higher for farmers who never adopted other modern *Striga* control technologies compared to that of those who were currently using a given technology. For example 61.3% of WeRATE farmers never adopted KSTP94 compared to 21.3% who were using the technology. Similarly, 51% of farmers never adopted WS909 compared to 31% who were using that technology in Western province. The low adoption rates are expected because few of the farmers were aware of those technologies. Exposure to a new technology is a pre-condition to its adoption by farmers.

Sources of information on modern *Striga* control technologies

In western Kenya, several media have been used to promote awareness on modern *Striga* control technologies. As far as IR maize is concerned, there has been substantial efforts to promote this technology. For the farmers who have heard of the technology their main sources of information were local NGOs and extension agents. The level of success of the other media also improved as shown in Table 4.5.

Table 4.5. Source of information on *Striga* control technologies (% of respondents, N = 834)

Sources of information	1*	2*	3*	4*	5*
Farmers in the village	3.33	6.31	7.28	6.00	3.59
Farmers in another village	1.93	7.21	6.62	2.00	2.40
Mass media (radio, newspapers)	1.18	0.90	5.30	4.00	5.39
Extension agents	48.12	10.81	15.89	31.00	10.18
Local NGOs	32.87	42.34	35.10	35.00	47.31
International research institutes	1.72	6.31	3.31	4.00	7.19
National research institute (KARI)	7.63	21.62	20.53	15.00	19.16
Community based organisations (CBOs)	3.22	4.50	5.96	3.00	4.79

1* IR maize variety (*Ua Kayongo*)
2* *Striga* tolerant maize KSTP94 (with legumes)
3* *Striga* tolerant maize WS909 (with legumes)
4* Intercropping of legumes followed by cassava/Desmodium
5* Push-pull (maize/Desmodium strip cropping)

Table 4.5 clearly indicates the importance of extension agents and local NGOs in promoting the use of IR maize technology. Both sources contributed to about 81% of the total sources of information on *Striga* control using IR maize technology. In fact the same sources have also shown greater importance on information dissemination on *Striga* control using other modern technologies. Indeed, the contribution by KARI in disseminating information to farmers on control of *Striga* was stunning. The role of farmers and community based organisations (CBOs) in information exchange and dissemination of technical information cannot be ignored.

Sources of information on modern *Striga* control technologies: Baseline vs WeRATE farmers

When the analysis was broken down to farmers who were experiencing the technology for the first time (baseline) and those who had experience with the technology for some time (WeRATE), the difference on sources of information on modern *Striga* control technologies was clearly observed. The prominent media in the baseline group of farmers was the extension agents complimented by local NGOs, KARI and CBOs. More evident was the dominance of extension agents (86.2%) on dissemination of information. Extension agents as a source of information was also important (50%) on control of *Striga* using intercropping of legumes followed by cassava/Desmodium and 45.2% as source of information on the use of *Striga* tolerant maize WS909 (with legumes). On the other hand, for the WeRATE farmers the common media was the local NGOs that registered 51.1%, 42.5%, 39.5%, 35.6% and 45.3% as source of information for the control of *Striga* using IR maize variety, *Striga* tolerant maize KSTP94 (with legumes), *Striga* tolerant maize WS909 (with legumes), intercropping of legumes followed by cassava/Desmodium and push-pull strip cropping, respectively. The significance of extension agents and KARI on information dissemination for the control of *Striga* for WeRATE farmers was also paramount as shown in Table 4.6.

Table 4.6. Sources of information on modern *Striga* control technologies: Baseline vs WeRATE farmers

	Baseline					WeRATE				
N	376					458				
Sources of information	1*	2*	3*	4*	5*	1*	2*	3*	4*	5*
Farmers in the village	2.2	14.3	18.2	0	0	4.2	5.7	5.4	6.7	3.5
Farmers in another village	0.5	0	4.5	0	0	3.1	7.5	7.0	2.2	2.3
Mass media (radio, newspapers)	1.0	0	4.5	0	16.7	1.4	0.9	5.4	4.4	4.7
Extension agents	86.2	14.3	45.5	50.0	0	17.8	10.4	10.9	28.9	9.9
Local NGOs	8.7	14.3	9.1	30.0	16.7	52.1	42.5	39.5	35.6	45.3
International research institutes	1.0	0	0	10.0	16.7	2.1	6.6	3.9	3.3	12.8
National research institute (KARI)	0.2	28.6	9.1	10.0	33.3	13.7	21.7	22.5	15.6	17.4
Community based organisations (CBOs)	0.2	28.6	9.1	0	16.7	5.6	4.7	5.4	3.3	4.1

1* IR maize variety (*Ua Kayongo*)
2* *Striga* tolerant maize KSTP94 (with legumes)
3* *Striga* tolerant maize WS909 (with legumes)
4* Intercropping of legumes followed by cassava/Desmodium
5* Push-pull (maize/Desmodium strip cropping)

Sources of information on modern *Striga* control technologies: Nyanza vs Western farmers

A comparison of sources of information for farmers from Western and Nyanza provinces indicate that the source of information on *Striga* control methods is from the extension agents complimented largely by the national research institute (KARI). The Western province farmers got information on *Striga* control mainly from the local NGOs working in the region. It is also evident that farmer's information exchange avenues are more pronounced in Western province than in Nyanza province; the reverse, however, holds for community based organisations in Nyanza province (Table 4.7).

Table 4.7. Sources of information on modern *Striga* control technologies: Nyanza vs Western farmers

	Nyanza					Western				
N	400					434				
Sources of information	1*	2*	3*	4*	5*	1*	2*	3*	4*	5*
Farmers in the village	3.5	1.9	2.7	3.4	4.2	3.2	10.5	11.5	9.8	2.9
Farmers in another village	2.8	11.1	8.2	0	0	1.1	3.5	5.1	4.9	3.9
Mass media (radio, newspapers)	1.1	1.9	0	1.7	2.8	1.3	0	10.3	7.3	6.9
Extension agents	50.2	16.7	13.7	49.2	15.5	46.1	5.3	17.9	4.9	5.9
Local NGOs	18.8	13.0	19.2	10.2	16.9	46.5	70.2	50.0	70.7	65.7
International research organisations	2.0	7.4	5.5	5.1	22.5	1.5	5.3	1.3	2.4	6.9
National research institute (KARI)	15.1	38.9	41.1	25.4	38.0	0.4	5.3	1.3	0	4.9
Community based organisations (CBOs)	6.6	9.3	9.6	5.1	0	0	0	2.6	0	2.9

1* IR maize variety (*Ua Kayongo*)
2* *Striga* tolerant maize KSTP94 (with legumes)
3* *Striga* tolerant maize WS909 (with legumes)
4* Intercropping of legumes followed by cassava/Desmodium
5* Push-pull (maize/Desmodium strip cropping)

Farmer perceptions on maize yields under different *Striga* control technologies

The perception of farmers on yields they expect under each *Striga* control technology provides an indication of their confidence on the ability of a technology to address the *Striga* problem. Farmers using the traditional *Striga* control approaches had the lowest expected harvest in all cases (Table 4.8). Farmers who had prior experience with improved technologies for control of *Striga* perceived maize yields to be higher. The results also indicated that under each of the modern *Striga* control technologies the expected maize yield would be higher in Western province than in Nyanza province.

The impact of using other *Striga* control technologies on improved land productivity showed much positive impact among WeRATE farmers compared to baseline farmers, possibly because the former group has been in touch with the technologies longer than the latter group. This shows the rationale of intervention of various organisations to nourish the lives of the poor rural populations. However, WeRATE farmers seemed to be more cautious about their expected maize yields from using IR maize compared to baseline farmers.

Table 4.8. Average expected yield of maize under different *Striga* control technologies

	All		Baseline		WeRATE		Nyanza		Western	
Striga control technologies	N	kg/ha	N	kg/ha	N	kg/ha	N	kg/ha	N	kg/ha
IR maize variety (*Ua Kayongo*)	342	1,702	40	1,832	302	1,685	141	1,678	201	1,719
Striga tolerant maize KSTP94 (with legumes)	18	1,416	1	1,005	17	1,440	5	1,215	13	1,494
Striga tolerant maize WS909 (with legumes)	45	1,260	5	900	40	1,305	18	1,213	27	1,292
Intercropping of legumes followed by cassava/ Desmodium	33	1,423	8	1,152	25	1,510	26	1,392	7	1,538
Push-pull (maize/ Desmodium strip cropping)	44	1,466	0	–	44	1,466	21	1,746	23	1,209
Traditional practices (manuring, uprooting, burning)	790	820	358	775	432	857	379	793	411	845

N = Number of respondents

Average years since adoption of the various *Striga* control technologies

In addition to having information on a technology, it is important that the farmers test these technologies with the intent of validating for potentiality. Perception of a farmer on a particular technology has been seen to improve with the period the said farmer has been exposed to the technology. Most of the farmers interviewed had been exposed to IR maize technology for at least one year and had been introduced to other modern *Striga* control technologies for more than two years while they have been using the traditional methods for more than eight years. In summary, farmers in western Kenya had little experience with using modern *Striga* control technologies.

Table 4.9. Average years since adoption of the various technologies

	All		Baseline		WeRATE		Nyanza		Western	
***Striga* control technologies**	N	Yrs	N	Yrs	N	Yrs	N	Yrs	N	Yrs
IR maize variety (*Ua Kayongo*)	834	0.8	376	0.5	458	1.1	400	0.8	434	0.9
Striga tolerant maize KSTP94 (with legumes)	18	2.1	1	1.0	17	2.2	5	2.2	13	2.1
Striga tolerant maize WS909 (with legumes)	45	2.2	5	2.4	40	2.1	18	2.1	27	2.2
Intercropping of legumes followed by cassava/ Desmodium	33	4.1	8	3.3	25	4.4	26	4.7	7	2.1
Push-pull (maize/Desmodium strip cropping)	44	2.0	0		44	2.0	21	2.0	23	2.1
Traditional practices (manuring, uprooting, burning)	788	9.5	360	7.5	428	11.1	380	7.9	408	11.0

N = Number of respondents

Perception on effectiveness of *Striga* control technologies

Farmers had varied perceptions on which technologies are effective in the control of *Striga*. In all cases however, IR maize was perceived to be the best in terms of reducing the *Striga* population on the farms (Table 4.10). This was followed by push-pull and then traditional practices. The baseline farmers however perceived that the traditional methods of *Striga* control come second to the IR maize technology. This would have been associated with the fact that they had not been exposed to the other technologies to a level that they could make a clear distinction between them. The effectiveness of IR maize to control *Striga* was ranked first among the WeRATE farmers followed by push-pull and then traditional practices. This implies that consistent manuring, uprooting and burning of *Striga* is perceived to reduce the *Striga* populations. The uprooting must however be done before the *Striga* plant produces more seeds.

There were minimal differences when the same technologies were compared by province. The results indicated that IR maize was perceived to be the most important in *Striga* reduction by farmers in both provinces. Farmers from Nyanza province perceived traditional practices the second best technology in the control of *Striga* infestation trailed by the push-pull technology. Farmers in Western province perceived push-pull as second followed by the traditional practices on *Striga* population reduction (Table 4.11).

Table 4.10. Perception on effectiveness of *Striga* control technologies per farmer category

	All			Baseline			WeRATE		
Striga reduction technologies	N	Mean	Rank	N	Mean	Rank	N	Mean	Rank
IR maize variety (*Ua Kayongo*)	832	1.06	1	376	1.05	1	456	1.07	1
Striga tolerant maize KSTP94 (with legumes)	70	3.46	6	2	2.50	5	68	3.49	6
Striga tolerant maize WS909 (with legumes)	132	3.06	5	27	2.74	6	105	3.14	4
Intercropping of legumes followed by cassava/ Desmodium	77	3.05	4	11	2.18	3	66	3.20	5
Push-pull (maize/ Desmodium strip cropping)	148	2.19	2	4	2.25	4	144	2.19	2
Traditional practices (manuring, uprooting, burning)	831	2.31	3	376	2.04	2	455	2.54	3

N = Number of respondents; Rank 1= Most effective; 6 = Least effective

Table 4.11. Perception on effectiveness of *Striga* control technologies per province

	Nyanza			Western		
Striga reduction technologies	N	Mean	Rank	N	Mean	Rank
IR maize variety (*Ua Kayongo*)	400	1.05	1	432	1.07	1
Striga tolerant maize KSTP94 (with legumes)	28	3.29	6	42	3.57	6
Striga tolerant maize WS909 (with legumes)	51	2.94	5	81	3.14	5
Intercropping of legumes followed by cassava/ Desmodium	45	2.93	4	32	3.22	4
Push-pull (maize/Desmodium strip cropping)	52	2.52	3	96	2.01	2
Traditional practices (manuring, uprooting, burning)	400	2.25	2	431	2.37	3

N = Number of respondents; Rank 1 = Most effective; 6 = Least effective

Knowledge of management practices for modern *Striga* control technologies

Potential adopters require the hardware (seed and fertiliser) as well as the software component (demonstrations on technology management) to enable them pass through the validation stage successfully. These two essential components were provided to the farmers through various media.

The most important agents that demonstrated how the various technologies are applied were the extension agents and the local NGOs. On IR maize, local NGOs reached 37% of the farmers, extension agents succeeded in diffusing the technology to 36% of the farmers and international research institutes reached at least 13% of the farmers. Local NGOs reached more farmers (38%) with the KSTP94 maize variety that is tolerant to *Striga* followed by KARI (23%), then extension agents (15%) followed by international research institutes (14%). Local NGOs, KARI and extension agents were the main agents involved in the dissemination of *Striga* tolerant WS909 *Striga* control technology. Extension agents and local NGOs were important sources of information on how to apply the intercropping of legumes followed by cassava and Desmodium technology. The push-pull technology was mainly disseminated by the local NGOs operating in western Kenya.

Table 4.12. Demonstrators of modern *Striga* control technologies

N			834		
Seed Management Demonstrator	1*	2*	3*	4*	5*
Farmers in the village	4.43	2.13	3.29	4.35	1.91
Farmers in other villages	1.3	7.45	3.95	2.17	3.18
Extension agents	35.75	14.89	21.71	38.04	7.64
Local NGOs	36.83	38.3	40.79	31.52	47.13
International research institute (CIMMYT)	12.74	13.83	8.55	6.52	10.19
National research institute (KARI)	5.72	23.4	21.71	14.13	20.38
Community based organisations (CBOs)	3.24	0	0	3.26	9.55

1* IR maize variety (*Ua Kayongo*)
2* *Striga* tolerant maize KSTP94 (with legumes)
3* *Striga* tolerant maize WS909 (with legumes)
4* Intercropping of legumes followed by cassava/Desmodium
5* Push-pull (maize/Desmodium strip cropping)

At the provincial level, Nyanza farmers received most of the information and demonstrations on *Striga* control technologies from the extension agents followed by the local NGOs and KARI (Table 4.13). For farmers in Western province, it was local NGOs that trumpeted the use of *Striga* control technologies more than any other agents though the work by extension agents and KARI cannot pass without due acknowledgement. Thus, farmers in western Kenya got the information and demonstrations on *Striga* control technologies mainly from the extension agents, local NGOs and KARI.

There were minimal variations on the sources of demonstrators when the analysis was reduced to baseline and WeRATE farmers. For the baseline farmers the main sources of dissemination of the technologies were the extension agents, while the WeRATE farmers accessed most *Striga* control information and demonstrations from the local NGOs (Table 4.14).

Table 4.13. Demonstrators of modern *Striga* control technologies: Nyanza vs Western farmers

	Nyanza (400)					Western (434)				
Demonstrators	1*	2*	3*	4*	5*	1*	2*	3*	4*	5*
Farmers in the village	5.78	3.92	3.90	3.45	4.23	3.15	–	2.67	5.88	–
Farmers in other villages	1.78	9.80	5.19	1.72	1.41	0.84	4.65	2.67	2.94	4.65
Extension agents	41.11	15.69	11.69	55.17	14.08	30.67	13.95	32.00	8.82	2.33
Local NGOs	29.33	17.65	22.08	10.34	33.80	50.21	62.79	60.00	76.47	75.58
International research institute (CIMMYT)	4.00	1.96	5.19	1.72	4.23	14.08	16.28	2.67	5.88	8.14
National research institute (KARI)	11.33	43.14	42.86	22.41	38.03	0.42	–	–	–	5.81
Community based organisations (CBOs)	6.67	7.84	9.09	5.17	4.23	0.63	2.33	–	–	3.49

Figures in brackets represent the number of respondents
1* IR maize variety (*Ua Kayongo*)
2* *Striga* tolerant maize KSTP94 (with legumes)
3* *Striga* tolerant maize WS909 (with legumes)
4* Intercropping of legumes followed by cassava/Desmodium
5* Push-pull (maize/Desmodium strip cropping)

Table 4.14. Demonstrators of modern *Striga* control technologies: Baseline vs WeRATE farmers

	Baseline (376)					WeRATE (458)				
Demonstrators	1*	2*	3*	4*	5*	1*	2*	3*	4*	5*
Farmers in the village	5.2	25	4.55	–	–	3.83	1.11	3.08	4.88	2.00
Farmers in other villages	0.74	–	4.55	–	–	1.72	7.78	3.85	2.44	3.33
Extension agents	63.86	50	68.18	90.00	–	13.98	13.33	13.85	31.71	8
Local NGOs	19.06	25	13.64	10.00	57.14	50.57	38.89	45.38	34.15	46.67
International research institutes	8.66	–	–	–	28.57	15.9	14.44	10.00	7.32	9.33
National research institute (KARI)	0.99	–	9.09	–	–	9.39	24.44	23.85	15.85	21.33
Community based organisations (CBOs)	1.49	–	–	–	14.29	4.6	–	–	3.66	9.33

Figures in brackets represent the number of respondents

Reasons for non-adoption of modern *Striga* control technologies

Both technology and specific household reasons can smoothen or impede the adoption process of a new technology. A number of respondents who were familiar with the modern *Striga* control technologies but had not adopted them gave varying reasons for non-adoption. These reasons ranged from gathering more information to cultural factors as indicated in Table 4.15. The results revealed that the majority (44%) of non-adopters were still gathering more information on the technologies, while 22% indicated that it was because of lack of improved seeds (*Striga* resistant varieties). Some (18%) pointed out that they lacked cash to buy improved seeds and other inputs. More than 16% of the respondents cited traditional methods as better and the modern technologies as too risky to adopt. Cultural factors too impeded the adoption of the new technologies. From these observations, it can easily be concluded that the underlying problem is the fear of change and thus a lot of effort needs to be geared towards the provision of the correct information.

Table 4.15. Reasons for non-adoption of modern *Striga* control technologies (% households)

	All	Baseline	WeRATE	Nyanza	Western
N	167	55	112	97	70
Gathering more information about the technology	44.31	30.91	50.89	30.93	62.86
Too risky to adopt	4.79	3.64	5.36	7.22	1.43
Lack of improved seeds (*Striga* resistant varieties)	21.56	25.45	19.64	29.90	10.00
Traditional control practices are better	10.18	25.45	2.68	13.40	5.71
Cash constraint to buy seeds and other inputs	17.96	12.73	20.54	16.49	20.00
Other factors (cultural factors)	1.20	1.82	0.89	2.06	0

N = Number of respondents

Sources of IR maize seed and knowledge of management practice for IR maize technology

Several channels were identified for the diffusion of the IR maize technology in western Kenya. The most important channels revealed were the extension agents from the Ministry of Agriculture who distributed IR maize seed to 44% of the target farmers. The local NGOs were another important channel that reached 43% of the target farmers. Most of the farmers in the baseline group got their IR maize seed from the extension agents of the Ministry of Agriculture while those in the WeRATE group got their seed from the local NGOs. Most of the farmers in Nyanza (58%) got their seed from the Ministry of Agriculture while most of those in Western (67%) got the IR maize seed from the local NGOs. In all cases, however, the two channels remain important in dissemination of the technology (Table 4.16). At this early stage of the deployment, only the public sector seems to play a big role in the diffusion of the new technology. For long term, it is important that the private sector (stockists) take over for the sustainability in the adoption of IR maize.

Table 4.16. Sources of IR maize seed for the 2006 long rains (% households)

Sources of IR maize seed	All	Baseline	WeRATE	Nyanza	Western
N	772	375	395	372	400
Ministry of Agriculture (extension agents)	44.04	72.00	17.63	58.33	30.75
Local NGOs	42.62	26.93	57.43	16.40	67.00
Neighbour/friend/relative	1.68	0.80	2.52	1.88	1.5
Community based organisations (CBOs)	4.92	0	9.57	10.22	–
National research institute (KARI)	5.70	0	11.08	11.83	–
Village elders	0.13	0.27	0	0	0.25
International research institutes (CGIAR)	1.04	0	1.76	1.34	0.5

N = Number of respondents

IR maize use guidelines

As earlier mentioned, apart from the hardware component of the technology there is need to integrate it with the software component. Due to the effect of the herbicide (*imazapyr*) used to coat the IR maize seed on other planting materials (seeds) not resistant to this herbicide, there is a need for carefully handling this variety of maize and other seeds for instance that of legumes. The IR maize was supplied to the farmers with guidelines on how to manage the seed. In addition, there were sessions to brief the farmers individually or in groups on how to apply this technology. Results presented in Table 4.17 indicate that a large majority (>90%) of the farmers understood the guidelines prior to the application of the technology.

Table 4.17. Understanding the guidelines on the use of IR maize technology

Household response	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
Yes (%)	93.65	97.07	90.83	95.50	91.94
No (%)	6.35	2.93	9.17	4.50	8.06

N = Number of respondents

Assessment on field test instructions before applying IR maize technology

Apart from the farmers being taken through the guidelines by either extension agents, local NGOs or other agents given the maize to distribute, the IR maize kit had field application guidelines on how to apply the technology. It is important for farmers to understand these guidelines before applying the technology short of which there would be negative consequences. Table 4.18 shows how farmers reacted to guidelines attached to the use of IR maize kit.

Table 4.18. Assessment on field test instructions before applying IR maize technology

Household response	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
Yes – read and understood (%)	79.86	83.24	77.07	81.75	78.11
Yes – read but could not understand (%)	3.84	4.26	3.49	2.00	5.53
No – did not read (%)	16.31	12.50	19.43	16.25	16.36

N = Number of respondents

The results in Table 4.18 reveal that though 80% of the farmers read and understood the field test instructions before applying the technology, 4% of them read but could not understand and 16% did not read at all. It was, however, not established if the farmers who did not read the instructions were illiterate or whether they were not given the field test instructions. The combination of written material and verbal instructions can achieve a greater level of success in delivering the guidelines to the farmers.

The effects of planting IR maize in the same hole as legumes

It is important that prospective adopters of a technology get the correct instructions on its management. The chemical coating on the IR maize seed is harmful on any other seed not resistant to it. This is why farmers were asked not to put the IR maize seed in the same hole as legume seeds. Table 4.19 presents the results on whether the farmers understood the effect of planting IR maize seed in the same hole as legumes. Majority of the farmers (>90%) understood the negative impact while less than 10% of the farmers did not understand.

Table 4.19. The effect of planting IR maize in same hole as legumes

Household response	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
Yes (%)	92.09	94.41	90.17	93.00	91.24
No (%)	7.91	5.59	9.83	7.00	8.76

N = Number of respondents

Application of the field test instructions

Apart from understanding the guidelines there was need to establish how many farmers followed the guidelines during the application of the technology. Most of the guidelines were adhered to by the farmers as shown in Table 4.20.

Table 4.20. Application of the field test instructions (% households)

Guidelines	All		Baseline		WeRATE		Nyanza		Western	
	Applied	Not applied	Applied	Not applied	Applied	Not applied	Applied	Not applied	Applied	Not applied
Wash hands after planting IR maize	99.11	0.89	99.46	0.54	98.81	1.19	99.0	1.0	99.30	0.70
Planting legumes before IR maize	41.27	58.73	35.50	64.50	46.32	53.68	26.2	73.8	55.6	44.40
Mark an area of 20×20m severely affected by *Striga* in the last season	79.62	20.38	68.83	31.17	89.07	10.93	83.4	16.6	76.00	24.00
Broadcast DAP and UREA across the soil surface and dig into the soil about 15cm	60.51	39.49	60.43	39.57	60.57	39.43	71.2	28.8	50.40	49.60
Do not plant IR maize in the same hole as legumes	87.09	12.91	83.74	16.26	90.02	9.98	82.1	17.9	91.90	8.10
Apply CAN fertiliser following the second weeding	80.58	19.42	82.88	17.12	78.57	21.43	84.4	15.6	77.00	23.00

The two guidelines that farmers had a problem applying were planting of legumes before the IR maize and broadcasting DAP and UREA across the soil surface and digging into the soil about 15cm.

For the non-planting of legumes before IR maize, the farmers advanced various reasons for non-application. The main reasons, however, included compromise with indigenous farming system (mixed sowing/planting) where the maize and the legume seeds are sometimes placed in the same hole. Some farmers (20%) pointed out that the process was time wasting while others (19%) indicated lack of inputs as reason for their non-adherence to the guidelines. Another group of farmers (13%) pointed to the fact that the guidelines had a cost implication. Farmers who had pure stand of IR maize (11%) did not have to follow this guideline. About 6% of the farmers who did not abide by this guideline mentioned lack of information as a reason for non-application.

A majority of farmers (45%) who did not apply the fourth guideline (broadcast DAP and UREA across the soil surface and dig into the soil about 15cm), explained that the guideline was time wasting while 32% of them pointed to the cost implication of applying this guideline. There were minimal variations between the reasons put forward by the WeRATE and baseline farmers as well as the Nyanza and Western province farmers.

Table 4.21. Reasons for non-application of various field-test instructions (% households)

	All					
N	7	464	161	312	102	153
Reasons for not applying	1*	2*	3*	4*	5*	6*
Time consuming/laborious	42.9	20.0	70.2	44.9	21.6	7.2
Compromise with indigenous farming system	0	28.0	16.1	2.2	5.9	7.8
Has cost implication	0	12.5	5.0	32.1	14.7	64.7
Makes me dependent on external agents	14.3	3.7	3.1	0.3	0	0
Lack of inputs	42.9	19.2	5.6	14.7	15.7	18.3
Did not intercrop	0	10.6	0	0.6	42.2	2.0
Put in planting holes	0	0	0	4.8	0	0
Not taught	0	6.0	0	0.3	0	0

N = Number of respondents (those who did not apply the guidelines)
1* Wash hands after planting IR maize
2* Planting legumes before IR maize
3* Mark an area of 20×20m severely affected by *Striga* in the last season
4* Broadcast DAP and UREA across the soil surface and dig into the soil about 15cm
5* Do not plant IR maize in the same hole as legumes
6* Apply CAN fertiliser following the second weeding

Difficulties in application of the guidelines

The ability to apply a stated guideline does not imply that the farmers had no hurdles in their applications. The farmers ranked the various guidelines with regards to difficulty in applying them. Farmers pointed out that the three most difficult guidelines were broadcast DAP and UREA across the soil surface and dig into the soil about 15cm, mark an area of 20×20m which was severely affected by *Striga* in the last season and plant legumes before IR maize in descending order (Table 4.22). The three guidelines were consistently ranked as either first, second or third by the various categories of farmers (baseline, WeRATE, Nyanza and Western).

Table 4.22. Ranking for the various guidelines with regard to difficulty in implementation

Guidelines	All		Baseline		WeRATE		Nyanza		Western	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
Wash hands after planting IR maize	4.26	5	4.65	6	3.92	4	4.41	6	4.12	5
Plant legumes before IR maize	3.32	3	3.05	3	3.55	3	3.57	3	3.07	3
Mark an area of 20×20m which was severely affected by *Striga* in the last season	2.58	2	2.70	2	2.47	1	2.55	2	2.60	2
Broadcast DAP and UREA across the soil surface, dig into the soil about 15cm	2.51	1	2.45	1	2.57	2	2.50	1	2.53	1
Do not plant IR maize in the same hole with legumes	4.05	4	4.02	4	4.08	5	4.32	4	3.81	4
Apply CAN fertiliser following the second weeding	4.32	6	4.15	5	4.47	6	3.73	5	4.88	6

Rank: 1 = Most difficult; 6 = Least difficult

Training on IR maize technology

Guidance and provision of adequate information for prospective adopters of a new technology are paramount for successful adoption of the technology. Several media were used to deliver the technology information to the farmers. Results revealed that the most important avenue was the training by the extension agents, farmer-to-farmer diffusion through individual visits, and official farmer exchange visits.

Extension agents, public *barazas* (meetings organised by the local administrative officers, e.g. the chief) and workshops were mainly used to get the guidelines on the application of the IR maize technology to the baseline farmers. Extension agents, workshops and farmer exchange visits were important in delivering the training on IR maize technology to the WeRATE farmers.

Table 4.25 illustrates that training on the IR maize application guidelines for farmers in Nyanza and Western provinces was mainly by the extension agents, farmer exchange visits and workshops.

Table 4.23. Types of trainings on IR maize technology guidelines

N	834					
Type of training	1*	2*	3*	4*	5*	6*
Workshops	21.67	21.76	16.48	22.61	21.89	21.67
Farmer exchange visits	15.24	13.39	60.38	13.03	12.42	12.55
Extension agents	45.83	45.75	19.02	45.85	47.6	47.78
Public barazas	14.76	16.88	4.12	15.45	16.61	15.21
Community based organisations (CBOs)	2.50	2.23	0.00	3.07	1.48	2.79

1* Wash hands after planting IR maize
2* Planting legumes before IR maize
3* Mark an area of 20×20m severely affected by *Striga* in the last season
4* Broadcast DAP and UREA across the soil surface and dig into the soil about 15cm
5* Do not plant IR maize in the same hole with legumes
6* Apply CAN fertiliser following the second weeding

Table 4.24. Types of training on IR maize technology guidelines: Baseline vs WeRATE

N	376						458					
	Baseline						WeRATE					
Type of training	1*	2*	3*	4*	5*	6*	1*	2*	3*	4*	5*	6*
Workshops	13.99	13.07	16.02	15.72	14.1	14.06	28.41	31.29	27.49	29.37	29.08	28.89
Farmer exchange visits	1.53	1.07	0.78	0.77	0.77	0.78	27.29	26.9	23.93	25.06	23.17	23.7
Extension agents	59.8	57.87	59.43	59.28	60.51	61.2	33.56	32.46	35.78	32.66	35.7	35.06
Public barazas	24.17	25.07	23.77	23.97	24.62	23.96	6.49	7.89	6.64	7.09	9.22	6.91
Community based organisations (CBOs)	0.51	2.93	0	0.26	0	0	4.25	1.46	6.16	5.82	2.84	5.43

1* Wash hands after planting IR maize
2* Planting legumes before IR maize
3* Mark an area of 20×20m severely affected by *Striga* in the last season
4* Broadcast DAP and UREA across the soil surface and dig into the soil about 15cm
5* Do not plant IR maize in the same hole with legumes
6* Apply CAN fertiliser following the second weeding

Table 4.25. Types of training on IR maize technology guidelines: Nyanza vs Western

N	400						434					
Type of training	Nyanza						Western					
	1*	2*	3*	4*	5*	6*	1*	2*	3*	4*	5*	6*
Workshops	14.84	0	6.85	8.67	8.23	8.31	16.63		37.50	36.57	36.00	36.05
Farmer exchange visits	58.88	12.66	12.22	11.99	11.62	11.49	35.48	22.53	13.50	14.07	13.25	13.68
Extension agents	15.33	62.34	59.90	58.16	60.05	59.66	15.14	53.75	34.00	33.50	34.75	35.00
Public *barazas*	4.87	19.81	14.91	15.31	17.19	15.16	0.25	23.72	14.75	15.60	16.00	15.26
Community based organisations (CBOs)	6.08	5.19	6.11	5.87	2.91	5.38	32.51	0	0.25	0.26	0	0

1* Wash hands after planting IR maize
2* Planting legumes before IR maize
3* Mark an area of 20x20m severely affected by *Striga* in the last season
4* Broadcast DAP and UREA across the soil surface and dig into the soil about 15cm
5* Do not plant IR maize in the same hole with legumes
6* Apply CAN fertiliser following the second weeding

Demonstration on IR maize technology management practice

Information can only be important when the practical demonstrations on how to apply the technology are clearly dealt with by demonstrators. Thus, in addition to information on the guidelines on the use of IR maize, the study sought to establish the channels and media used to demonstrate the finer details of how to apply the various guidelines.

Table 4.26. Demonstrators on IR maize technology management practice (% households)

Demonstrators	1*	2*	3*	4*	5*	6*
Extension agents	48.19	50.07	47.17	49.94	48.64	50.06
Local NGOs	37.44	35.61	37.93	36.97	36.63	35.92
International research institutes	2.54	4.31	3.82	3.08	3.71	2.13
National research institute (KARI)	7.49	4.31	5.91	5.65	6.31	7.26
Community based organisations (CBOs)	3.99	4.73	4.80	4.11	4.21	4.26
Other farmers	0.36	0.97	0.37	0.26	0.50	0.38

1* Wash hands after planting IR maize
2* Plant legumes before IR maize
3* Mark an area of 20×20m that was severely affected by *Striga* in the last season
4* Broadcast DAP and UREA across the soil surface and dig into the soil about 15cm
5* Do not plant IR maize in the same hole with legumes
6* How to intercrop IR maize with other legumes

The results in Table 4.26 disclose the importance of extension agents not only in technology information transfer but in demonstrations on how to apply the technology. The extension agents followed by local NGOs demonstrated a majority of the guidelines to the farmers (Tables 4.27 and 4.28).

Table 4.27. Demonstrators on the IR maize technology management practice: Baseline vs WeRATE farmers (% households)

Demonstrator	Baseline						WeRATE					
	1*	2*	3*	4*	5*	6*	1*	2*	3*	4*	5*	6*
Extension agents	78.59	75.27	75.45	78.72	78.92	82.29	20.19	23.65	20.90	21.08	20.53	20.24
Local NGOs	17.13	17.12	17.65	16.41	14.91	14.84	56.15	54.99	56.77	57.58	56.80	55.42
International research institutes	2.52	5.16	5.37	3.33	4.88	1.56	2.55	3.42	2.38	2.83	2.63	2.65
National research institute (KARI)	0.25	0	0	0	0	0	14.15	8.83	11.40	11.31	12.17	13.98
Community based organisations (CBOs)	1.51	1.36	1.53	1.54	1.29	1.30	6.26	8.26	7.84	6.68	6.92	6.99
Other farmers	0	1.09	0	0	0	0	0.70	0.85	0.71	0.51	0.95	0.72

1* Wash hands after planting IR maize
2* Plant legumes before IR maize
3* Mark an area of 20×20m that was severely affected by *Striga* in the last season
4* Broadcast DAP and UREA across the soil surface and dig into the soil about 15cm
5* Do not plant IR maize in the same hole with legumes
6* How to intercrop IR maize with other legumes

Table 4.28. Demonstrators on the IR maize technology management practice: Nyanza vs Western (% households)

	Nyanza						Western					
Guidelines	1*	2*	3*	4*	5*	6*	1*	2*	3*	4*	5*	6*
Extension agents	54.68	60.84	55.01	58.11	56.27	54.82	41.94	41.95	39.95	42.54	41.49	45.43
Local NGOs	20.44	13.59	20.82	19.19	19.44	19.29	53.79	52.20	53.66	53.06	52.76	52.10
International research institutes	1.48	2.59	1.54	1.62	1.79	1.78	3.55	5.61	5.91	4.40	5.52	2.47
National research institute (KARI)	14.53	9.71	12.08	11.89	12.79	14.72	0.71	0.24	0.24	0.00	0.24	0.00
Community based organisations (CBOs)	8.13	11.00	9.77	8.65	8.70	8.63	0	0	0.24	0	0	0
Other farmers	0.74	2.27	0.77	0.54	1.02	0.76	0	0	0	0	0	0

1* Wash hands after planting IR maize
2* Plant legumes before IR maize
3* Mark an area of 20×20m that was severely affected by *Striga* in the last season
4* Broadcast DAP and UREA across the soil surface and dig into the soil about 15cm
5* Do not plant IR maize in the same hole with legumes
6* How to intercrop IR maize with other legumes

Chapter 5

Perceptions on IR maize productivity and farm management practices

Farmer perceptions on agronomy attributes of maize varieties grown: The scoring approach

Farmers could be motivated to adopt new technologies if they perceive the utility of the new technology as larger than that of the existing one, be it traditional or modern technologies. The utility perception of the farmers in this case can be influenced by the technology specific characteristics.

Farmers in western Kenya grow three different varieties of maize. Local maize variety is by far the most common one followed by hybrid maize varieties (often farmers refer to Open Pollinated Varieties (OPVs) as hybrid maize). In addition to these two types of varieties, there is a new variety, the IR maize, which is meant to control the effect of *Striga* on the *Striga*-infested farms.

These varieties were evaluated for preference against nine agronomy attributes: maize yield, technical simplicity, cost of management, *Striga* population reduction, enhancement of soil fertility, vegetative vigour, ability to withstand abiotic factors, ability to withstand biotic factors and time to maturity. These agronomic attributes were adopted to allow baseline farmers who were experiencing the IR maize technology for the first time to be able to take part in the evaluation of the three types of maize. Each attribute received a score of 1 for the best rank and a score of 3 for the least rank. Scores by all the respondents were summed up and the average calculated. The average desired best score would be 9 and the average worst score would be 27 (with a mean score of 18). Table 5.1 presents the results.

Table 5.1. Overall ranking of the maize varieties based on agronomy attributes

Maize varieties	All		Baseline		WeRATE		Nyanza		Western	
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
Mean scores of IR maize	832	14.27	375	14.79	457	13.84	400	13.67	432	14.82
Mean scores of local maize	821	19.81	371	19.15	450	20.36	395	19.25	426	20.34
Mean scores of hybrid maize	759	19.22	319	18.79	440	19.54	335	19.95	424	18.65

N = Number of respondents; the smaller the average mean the better the rank

Most of the farmers ranked IR maize as the overall best variety followed by hybrid and lastly the local maize varieties. The trend is consistent across the farmer categories except for Nyanza where local maize outperforms the hybrid maize. This rose from the fact that most farmers in Nyanza use local maize variety. The other interesting phenomenon revealed by the results is the difference between the means of IR maize, local maize and hybrid in all the cases. It is evident that the difference in hybrid maize and local maize mean is very close (<1). On the other hand the difference between the mean of IR maize and that of either hybrid or local maize is large enough (>5) in all cases. This directly implies advantage the IR maize has over the other maize varieties in areas infested by *Striga*. From this result, one can also deduce that despite the fact that local maize is popularly grown in western Kenya, its productivity is very low hence hunger and starvation are common in the region. The use of improved varieties that ensure high yield and at the same time fight *Striga* infestation should be emphasised.

Ranking of maize varieties against agronomic factors

The same scoring approach was calculated for each attribute. The best expected average score would be 1 while the worst average score would be 3 on each attribute. The results in Table 5.2 make it possible to compare the three maize types on a specific attribute (column-wise) and to compare the same type of maize on all the nine attributes (row-wise). Row-wise, IR maize scored highly on *Striga* reduction, soil fertility enhancement, ability to withstand biotic and abiotic factors, and early maturity performance factors. Column-wise, hybrid maize ranked best in two performance factors, yield and vegetative vigour, whereas local maize was superior in technical simplicity and low maintenance cost.

Table 5.2. General ranking of maize varieties against agronomic factors

Maize varieties	1*	2*	3*	4*	5*	6*	7*	8*	9*
IR maize	2	3	2	1	1	2	1	1	1
Local maize	3	1	1	2	3	3	2	2	2
Hybrid maize	1	2	3	3	2	1	3	3	3

1* Maize yield
2* Technical simplicity
3* Management cost
4* *Striga* population reduction
5* Soil fertility enhancement
6* Vegetative vigour
7* Withstand abiotic factors
8* Withstand biotic factors
9* Time to maturity

WeRATE farmers ranked IR maize highly with regard to yield, *Striga* population reduction, ability to withstand abiotic and biotic factors as well as early maturity. Local maize varieties were ranked best in technical simplicity and low management cost. Hybrid maize was graded best in vegetative vigour only (Table 5.3).

Table 5.3. Ranking of maize varieties against agronomic factors by WeRATE farmers

Maize varieties	1*	2*	3*	4*	5*	6*	7*	8*	9*
IR maize	1	3	2	1	1	2	1	1	1
Local maize	3	1	1	3	3	3	2	2	2
Hybrid maize	2	2	3	2	2	1	3	3	3

1* Yield
2* Technical simplicity
3* Management cost
4* *Striga* population reduction
5* Soil fertility enhancement
6* Vegetative vigour
7* Withstand abiotic factors
8* Withstand biotic factors
9* Time to maturity

When the new (baseline) farmer perceptions was analysed, the results revealed that there were minimal differences between them and the older farmers' ranking of the maize varieties against the performance factors. Except for yield, which the baseline farmers felt that hybrid maize would give a higher yield than IR maize, all the other factors hold the same ranks between the groups (Table 5.4).

Table 5.4. Ranking of maize varieties against agronomic factors by baseline farmers

Maize varieties	1*	2*	3*	4*	5*	6*	7*	8*	9*
IR maize	2	3	3	1	1	2	1	1	1
Local maize	3	1	1	2	3	3	2	2	2
Hybrid maize	1	2	2	3	2	1	3	3	3

1* Yield
2* Technical simplicity
3* Management cost
4* *Striga* population reduction
5* Soil fertility enhancement
6* Vegetative vigour
7* Withstand abiotic factors
8* Withstand biotic factors
9* Time to maturity

Farmer perceptions on performance attributes of maize varieties: The frequency approach

Apart from the performance factors there were performance attributes, which were important to farmers. Attempts were made to understand the farmer perceptions of these factors against maize varieties and the results are presented in Table 5.5. IR maize had four positive attributes of early maturity, ability to disperse *Striga*, and resistance to biotic and abiotic stresses. These were however weighed against three less positive attributes of high labour requirement, high input, and complexity in farm management. The results too pointed out that hybrid maize had four positive attributes of high yield, high biomass, high market returns and ease to selling due to colour attractiveness. Local maize had two positive attributes of tasty *ugali* (corn meal) and tasty green maize.

Table 5.5. Ranking of maize varieties against various attributes (% households)

Attributes	N	IR	Hybrid	Local
High yield	831	45.37	49.70	4.93
High biomass	824	33.86	46.12	20.02
Tasty *ugali*	830	24.34	23.25	52.41
Tasty green maize	830	19.88	23.25	56.87
Early maturity	831	50.42	15.64	33.94
Disperse *Striga*	828	75.36	22.10	2.54
Resistant to biotic stress (weeds, pests, diseases)	825	62.42	15.39	22.18
Resistant to abiotic stress (wind, cold, drought)	831	60.77	17.21	22.02
High labour requirements	833	48.86	35.77	15.37
High input	830	43.73	40.12	16.14
Careful/complex farm management	830	63.25	29.76	6.99
High management cost	818	44.01	39.49	16.50
Easy to sell (colour attractiveness)	824	16.63	48.67	34.71
High market return (weight)	819	18.19	50.67	31.14
Less susceptible to storage pests (rats, weevils)	831	19.74	13.84	66.43
Requires no/less post-harvest dusting	830	19.88	10.60	69.52

N = Number of respondents

The WeRATE farmers pointed out that IR maize had a higher yield compared to hybrid maize (Table 5.6). They also had a feeling that hybrid maize had a higher management cost compared to IR and local maize varieties. The baseline farmers however, pointed out that local maize was easier to sell due to colour attractiveness compared to IR maize and hybrid varieties**.**

The overall trend was also reflected by the Nyanza and Western province farmers (Table 5.7). The farmers in Nyanza revealed that IR maize had higher yields and higher biomass compared to the other two varieties. The Western province farmers, because of better intensification of agriculture, pointed out that hybrid maize required higher inputs and high management cost.

Table 5.6. Ranking of maize varieties against various attributes: Baseline vs WeRATE farmers (% households)

	Baseline				WeRATE			
Attributes	N	IR	Hybrid	Local	N	IR	Hybrid	Local
High yield	375	35.20	58.40	6.40	456	53.73	42.54	3.73
High biomass	371	32.88	40.43	26.68	453	34.66	50.77	14.57
Tasty *ugali*	373	7.51	26.01	66.49	457	38.07	21.01	40.92
Tasty green maize	372	8.33	17.47	74.19	458	29.26	27.95	42.79
Early maturity	374	50.53	16.58	32.89	457	50.33	14.88	34.79
Disperse *Striga*	374	74.06	23.53	2.41	454	76.43	20.93	2.64
Resistant to biotic stress (weeds, pests, diseases)	370	60.27	14.59	25.14	455	64.18	16.04	19.78
Resistant to abiotic stress (wind, cold, drought)	375	62.13	14.67	23.20	456	59.65	19.30	21.05
High labour requirements	375	48.27	39.47	12.27	458	49.34	32.75	17.90
High input	374	48.66	36.90	14.44	456	39.69	42.76	17.54
Careful/complex farm management	375	63.20	29.87	6.93	455	63.30	29.67	7.03
High management cost	368	48.91	36.14	14.95	450	40.00	42.22	17.78
Easy to sell (colour attractiveness)	372	7.26	51.34	41.40	452	24.34	46.46	29.20
High market return (weight)	369	8.40	55.28	36.31	450	26.22	46.89	26.89
Less susceptible to storage pests (rats, weevils)	374	3.21	8.29	88.50	457	33.26	18.38	48.36
Requires no/less post-harvest dusting	375	2.93	5.60	91.47	455	33.85	14.73	51.43

N = Number of respondents

IR maize productivity

Data on the productivity of IR maize were collected at two periods of time: before and at harvest. Before harvest, data were related to farmer expectations of yield looking at the vegetative growth of crops during the 2006 long rains. Results show on average that farmers expected more than 2 tonnes of IR maize per hectare. The WeRATE farmers had higher expectations on IR maize yield (2,544kg/ha) compared to the baseline farmers who expected 2,336kg/ha. Western farmers had high expectations of 2,506kg/ha compared to Nyanza farmers whose expectation was 2,367kg/ha.

The actual harvests were obtained by recording the quantity harvested in each plot and dividing it over the area measured using GPS. The results show that actual yields were higher than the expected yields by the farmers. For plots that had IR maize sole, the maize yields were more than 2.5 tonnes per hectare while where the IR maize was intercropped the yield was close to 3 tonnes per hectare. Local maize yields were lower with an average of 1.5 tonnes/ha while hybrid yields were close to 2.5 tonnes/ha. The other observable trend was that where maize varieties were intercropped the yield was slightly higher than where it was sole grown except for the WeRATE farmers (Tables 5.9 and 5.10). This could be associated with the beneficial relationship between maize and legume crops. In all cases maize production from WeRATE farmers was higher than from baseline farmers. The WeRATE farmers had benefited more from earlier exposure and more extension services from both the Ministry of Agriculture and the local NGOs.

Table 5.7. Ranking of maize varieties against various attributes: Nyanza vs Western farmers (% households)

	Nyanza				Western			
Attributes	N	IR	Hybrid	Local	N	IR	Hybrid	Local
High yield	398	59.30	34.42	6.28	433	32.56	63.74	3.70
High biomass	390	50.51	21.28	28.21	434	18.89	68.43	12.67
Tasty *ugali*	400	27.50	14.75	57.75	430	21.40	31.16	47.44
Tasty green maize	400	21.25	12.25	66.50	430	18.60	33.49	47.91
Early maturity	399	48.62	20.55	30.83	432	52.08	11.11	36.81
Disperse *Striga*	395	67.85	29.11	3.04	433	82.22	15.70	2.08
Resistant to biotic stress (weeds, pests, diseases)	397	54.91	16.88	28.21	428	69.39	14.02	16.59
Resistant to abiotic stress (wind, cold, drought)	399	55.39	22.81	21.80	432	65.74	12.04	22.22
High labour requirements	400	52.75	25.75	21.50	433	45.27	45.03	9.70
High input	398	50.00	29.90	20.10	432	37.96	49.54	12.50
Careful/complex farm management	396	59.09	31.82	9.09	434	67.05	27.88	5.07
High management cost attribute	393	48.60	31.55	19.85	425	39.76	46.82	13.41
Easy to sell (colour attractiveness)	393	18.32	36.64	45.04	431	15.08	59.63	25.29
High market return (weight)	392	23.98	40.05	35.97	427	12.88	60.42	26.70
Less susceptible to storage pests (rats, weevils)	398	19.10	11.56	69.35	433	20.32	15.94	63.74
Requires no/less post-harvest dusting	398	17.34	10.30	72.36	432	22.22	10.88	66.90

N = Number of respondents

Table 5.8. Expected harvests from the IR maize plots for the 2006 long rains

Categories	N	Mean (kg/ha)	SD
All	755	2,440	83.64
Baseline	375	2,336	81.23
WeRATE	380	2,544	85.85
Nyanza	357	2,367	87.48
Western	398	2,506	80.05

Table 5.9. Actual maize harvests for the 2006 long rains

Maize cropping systems	All			Baseline			WeRATE		
	N	kg/ha	SD	N	kg/ha	SD	N	kg/ha	SD
IR maize sole	420	2,591	1.92	217	2,251	1.84	203	2,955	1.94
IR maize intercropped	335	2,682	2.07	159	2,526	2.18	176	2,822	1.96
Local maize sole stand 2006	192	1,580	0.92	69	1,456	0.80	123	1,650	0.97
Local maize intercropped	451	1,585	1.04	225	1,367	0.90	226	1,801	1.12
Hybrid maize sole	97	2,339	1.55	23	2,579	1.93	74	2,265	1.41
Hybrid maize intercropped	230	2,428	2.10	75	2,309	2.46	155	2,485	1.90

N = Number of respondents

Analysis of maize productions per province reveal that Nyanza farmers got higher maize yields than the Western province farmers. This could be attributed to many reasons. Farmers in Nyanza have intensified their agriculture coupled with the favourable climatic conditions. Most of the farmers in Nyanza had small parcels, which are easier to manage compared to large plots for farmers in Western. Nyanza farmers put in more organic fertilisers than their Western province counterparts. The seed application was closer to recommendations by the Nyanza farmers as opposed to those in Western. For instance the minimum quantity of maize seed per ha was 26kg/ha for Nyanza compared to 27kg/ha for Western, while the maximum stood at 34kg/ha and 39kg/ha respectively. This can also be ascertained from the land allocations to crops. The Nyanza farmers for instance put the 1kg of IR maize received on 0.03ha as recommended compared to 0.05ha in Western province on average. Most of the farmers in Nyanza planted on time especially for the long rains thus leading to higher harvests for them compared to farmers in Western province.

Table 5.10. Actual maize harvests in Nyanza and Western provinces (2006 long rains)

	Nyanza			Western		
Maize cropping systems	N	kg/ha	SD	N	kg/ha	SD
IR maize sole	266	2,733	1.83	154	2,345	2.04
IR maize intercropped	95	2,967	2.29	240	2,569	1.97
Local maize sole	135	1,620	0.85	57	1,487	1.06
Local maize intercropped	225	1,453	0.94	226	1,715	1.12
Hybrid maize sole	43	2,644	1.47	54	2,097	1.58
Hybrid maize intercropped	56	2,561	2.38	174	2,385	2.00

N = Number of respondents

Changes in farm management practices

It is always anticipated that with the introduction of new technology there are likely to occur changes in farm management practices as well as farming systems. The common practice in western Kenya is that once farm output is ensured, weeding is done twice. The results show that the majority (63%) of farmers in the Lake zone of Kenya normally weed their maize farms twice before maturity (Table 5.11). Some other farmers (26%) weed only once while about 11% weed thrice. More baseline farmers (34%) weed their farms once compared to WeRATE farmers (19%). More than 80% of the WeRATE farmers weed their farms at least two times.

Table 5.11. Number of times farmers weed their maize field before introduction of IR maize technology (% households)

Number of weeding times	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
Once	26.02	34.31	19.21	29.75	22.58
Twice	63.07	57.98	67.25	65.25	61.06
Thrice	10.91	7.71	13.54	5.00	16.36

N = Number of respondents

Less than 30% of the farmers pointed out that there were changes in the number of times they weeded their maize farms after the introduction of IR maize. More than 75% of the WeRATE farmers indicated that there had been no change in the number of times they weed their maize farms after the introduction of IR maize (Table 5.12).

Table 5.12. Changes in weeding due to introduction of IR maize technology (% households)

Response	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
Yes	29.26	35.11	24.45	32.25	26.50
No	70.74	64.89	75.55	67.75	73.50

N = Number of respondents

Table 5.13. Number of times farmers weed after introduction of IR maize technology (% households)

Weeding times	All	Baseline	WeRATE	Nyanza	Western
N	244	132	112	129	115
Once	20.49	12.88	29.46	21.71	19.13
Twice	72.13	79.55	63.39	72.09	72.17
Thrice	7.35	6.82	7.14	5.43	8.70

N = Number of respondents

Generally, changes in weeding show that more households are now weeding their maize fields twice and the number of those weeding once or thrice has reduced.

Initially, due to the high *Striga* infestation, farmers could weed only once and when the attack from *Striga* was severe, they gave up and left the field under *Striga* attack. Other households could keep up weeding more than twice hoping that they would suppress the weed. With the introduction of IR maize technology, more farmers went back to the normal weeding times (two times). This is because IR maize reduces *Striga* and assures the farmer of high maize yields.

Changes in farm management associated with adoption of IR maize technology

As earlier mentioned, adoption of new technologies can bring about changes in land use and other farm management practices. A technology that threatens the existing ways of farming may face rejection where the farmers are not ready for such changes. In this study, efforts were made to establish positive and negative changes from adopting IR maize. Possible implications were classified as either highly likely to occur, intermediate and less likely to happen. The farmers felt that the introduction of IR maize might have implications in terms of capital requirement and careful farm management. However, the majority of them considered that the new technology did not pose possibilities of major changes in farm management practices as outlined in Table 5.14.

Table 5.14. Changes in farm management associated with adoption of IR maize technology (% households)

Implications	Highly likely	Intermediate	Less likely
Disperse other crops/location change	20.98	26.62	52.40
Delay other crops	3.36	17.99	78.66
Disperse indigenous intercropping system	17.63	42.93	39.45
Intensive labour requirements	37.17	38.13	24.70
Disperse farm labour organisation	14.15	35.37	50.48
Require capital intensiveness	40.41	36.33	23.26
Lead to land use change	26.86	36.69	36.45
Require careful farm management	54.32	32.73	12.95
Consumes the labour of other farming activities	19.06	23.26	57.67

The above perception was consistent through the various categories of farmers. There were no major differences in the feeling of the baseline farmers from that of the WeRATE farmers nor that of Nyanza and Western provinces as tabulated in Tables 5.15 and 5.16.

Table 5.15. Changes in farm management associated with adoption of IR maize technology: Baseline vs WeRATE (% households)

	Baseline			WeRATE		
Implications	Highly likely	Intermediate	Less likely	Highly likely	Intermediate	Less likely
Disperse other crops/location change	12.77	26.33	60.90	27.73	26.86	45.41
Delay other crops	2.66	18.88	78.46	3.93	17.25	78.82
Disperse indigenous intercropping system	11.97	38.30	49.73	22.27	46.72	31.00
Intensive labour requirements	35.37	38.83	25.80	38.65	37.55	23.80
Disperse farm labour organisation	16.22	31.65	52.13	12.45	38.43	49.13
Require capital intensiveness	40.69	35.90	23.40	40.17	36.68	23.14
Lead to land use change	22.87	38.56	38.56	30.13	35.15	34.72
Require careful farm management	51.06	32.71	16.22	56.99	32.75	10.26
Consumes the labour of other farming activities	19.95	23.40	56.65	18.34	23.14	58.52

Table 5.16. Changes in farm management associated with adoption of IR maize technology: Nyanza vs Western (% households)

Implications	Nyanza baseline			Western baseline		
	Highly likely	Intermediate	Less likely	Highly likely	Intermediate	Less likely
Disperse other crops/ location change	16.00	26.25	57.75	25.58	26.96	47.47
Delay other crops	1.25	11.50	87.25	5.30	23.96	70.74
Disperse indigenous intercropping system	14.50	42.75	42.75	20.51	43.09	36.41
Intensive labour requirements	34.75	39.50	25.75	39.40	36.87	23.73
Disperse farm labour organisation	13.00	33.50	53.50	15.21	37.10	47.70
Require capital intensiveness	37.25	44.25	18.50	43.32	29.03	27.65
Lead to land use change	26.50	38.00	35.50	27.19	35.48	37.33
Require careful farm management	49.75	38.25	12.00	58.53	27.65	13.82
Consumes the labour of other farming activities	18.75	25.75	55.50	19.35	20.97	59.68

Social implications of the introduction of IR maize technology

Apart from changes in the farm management, a new technology can also bring about changes in the way a society operates. About 58% of the farmers felt that the technology was likely to bring changes in social cohesion as well as dispersion while 42% felt the technology was not likely to bring in any change. More baseline farmers (54%) felt that the technology would not bring in any social change while more than 68% of the WeRATE farmers felt that the technology would bring in social change. More than 50% of the farmers in Nyanza and Western province pointed to the possibility of the technology bringing in social change as shown in Table 5.17.

Table 5.17. The effect of IR maize on social cohesion (% households)

Likelihood	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
Highly likely	23.74	14.36	31.44	22.75	24.65
Likely	34.17	31.65	36.24	34.75	33.64
Not likely	42.09	53.99	32.31	42.50	41.71

N = Number of respondents

Four main social implications were identified during this study. Out of 483 farmers who indicated that the technology would bring about social changes, 77% of them felt that the technology would bring in positive changes of farmers forming groups while 14% pointed to the possibility of the technology leading to the formation of credit societies (Table 5.18). In farming communities, associations offer many opportunities to boost agricultural production by providing numerous forms of support to farmers. It is also through such groups that it becomes easier to access new technologies and opportunities.

It is however important to note that 9% of the respondents anticipated that the technology would bring in undesirable change. Eight percent (8%) pointed out that the technology was labour intensive and therefore they would have limited time to meet with community members while 1% alluded to the technology's possibility to bring in social ties disintegration. This would be associated to the inability to give the IR maize seed to all the farmers in the areas where the IR maize was being tested. It is also worth mentioning that the distribution systems that at times tended to favour some persons in the community would have led to some farmers feeling left out.

The WeRATE farmers were more positive about the technology introducing closer ties in the community with more than 95% of them pointing to the possibility of it bringing in the need to form farmer groups and credit societies. This reinforced the results of social capital analysis that revealed that most (>93%) of the WeRATE farmers belong to groups compared to 70% of the baseline farmers.

Table 5.18. Type of social cohesion strengthened/dispersed (% households)

Type of social cohesion	All	Baseline	WeRATE	Nyanza	Western
N	483	203	148	230	253
Lead to formation of farmer groups	76.81	60.69	85.81	67.83	84.98
Lead to formation of credit societies	14.08	24.28	8.39	23.91	5.14
Too labour intensive – no time to meet with community members	7.66	12.72	4.84	7.83	7.51
Lead to disintegration of social ties	1.45	2.31	0.97	0.43	2.37

N = Number of respondents

Farmer perceptions on appropriateness of IR maize and scale up

The general perception on the appropriateness of a technology to the sampled farmers and those not sampled is important before the full deployment of any new technology. It is also wise to establish the diffusion channels of this technology in the study areas to facilitate the scaling up/out of the technology. The majority (>50%) of the farmers indicated that the technology was highly appropriate. The WeRATE farmers were more enthusiastic (65%) compared to the baseline farmers (47%). The results (Table 5.19) also revealed that farmers in Nyanza province (60%) appreciated the IR maize technology more than their counterparts in Western province (54%).

Table 5.19. IR maize technology appropriateness (%)

Appropriateness	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
Highly appropriate	56.83	47.34	64.55	59.90	53.92
Moderately appropriate	38.37	47.07	31.29	39.35	37.56
Less appropriate	4.80	5.59	4.16	0.75	8.53

N = Number of respondents

The comments made on appropriateness of the IR maize technology by sampled farmers in the study area also apply to not sampled farmers. Sampled farmers were asked to assess what not sampled farmers would think about the appropriateness of IR maize. Results are shown in Table 5.20. The responses are similar to those from own perceptions of sampled farmers. Sharing of information among farmers (sampled and not sampled) could explain the general positive perception on IR maize. The results in Table 5.21, point to the fact that most sampled farmers (86%) shared the information on IR maize with others in the study area.

Table 5.20. Perception of not sampled farmers on IR maize as assessed by sampled farmers (%)

Appropriateness	All	Baseline	WeRATE	Nyanza	Western
N	815	365	450	388	427
Highly appropriate	51.29	38.90	61.33	56.95	46.14
Moderately appropriate	39.14	49.59	30.67	40.21	38.17
Less appropriate	9.57	11.51	8.00	2.84	15.69

N = Number of respondents

Table 5.21. Sharing information on IR maize technology with other farmers outside the study area (%)

Response	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
Yes	85.73	80.59	89.96	85.50	85.94
No	14.27	19.41	10.04	14.50	14.06

N = Number of respondents

Sharing of information on IR maize technology was mainly through individual farmer visits, farmer groups and societies. These were however reinforced by official farmers exchange visits, chief *barazas*, and a few through clubs and bars (Table 5.22).

Table 5.22. Media used to share information

Type of media	All (834)		Baseline (376)		WeRATE (458)		Nyanza (400)		Western (434)	
	N	%	N	%	N	%	N	%	N	%
Individual visiting	551	66.07	211	56.12	340	74.24	252	63.00	299	68.89
Official village/district farmer exchange visits	186	22.30	91	24.20	95	20.74	111	27.75	75	17.28
Chief *barazas*	193	23.14	74	19.68	119	25.98	75	18.75	118	27.19
Clubs/bars	51	6.12	19	5.05	32	6.99	29	7.25	22	5.07
Farmer groups/ societies	303	36.33	71	18.88	232	50.66	115	28.75	188	43.32

N = Number of respondents

Constraints in application of IR maize technology and scale up options

Farmers sometimes face a number of constraints in their adoption of a new technology. Early identification of these hindrances can greatly help in the development of deployment strategies to increase rates of adoption. The most important constraints identified during this study are presented in Table 5.23. The limited accessibility to and unavailability of IR maize seed were cited as the biggest constraints in the use of the IR maize package. The ranking was maintained when analysed with regard to farmer categories and regional differences as indicated in Tables 5.24 and 5.25, respectively.

Table 5.23. Constraints in the application of IR maize technology

Constraints	Mean score computation (Ranking)		
	N	Mean	Rank
Limited accessibility to IR maize kit	648	1.99	1
IR maize kit not available	510	2.58	2
Very little IR maize supplied	627	2.61	3
Very difficult to follow IR maize kit conditions/guidelines	457	3.31	6
Limited information on the technology	515	3.14	5
Prefer the traditional methods in controlling *Striga*	230	4.20	8
IR maize seeds are expensive	162	4.35	9
Weather (rainfall unreliability, cold, drought)	308	3.02	4
Farm size	174	3.50	7
Land availability	104	5.28	10
Lodging	35	6.80	12
Weeds, pests and diseases	74	6.39	11

N = Number of respondents

Note: The smaller the mean the more important the constraint

Table 5.24. Constraints in application of IR maize technology: Baseline vs WeRATE farmers

IR maize technology constraints	Baseline			WeRATE		
	N	Mean	Rank	N	Mean	Rank
Limited accessibility to IR maize kit	273	2.11	1	375	1.90	1
IR maize kit not available	202	2.43	2	308	2.68	3
Very little IR maize supplied	284	2.64	3	343	2.59	2
Very difficult to follow IR maize kit conditions/ guidelines	200	3.21	6	257	3.39	6
Limited information on the technology	236	2.92	5	279	3.32	5
Prefer the traditional methods in controlling *Striga*	109	4.47	10	121	3.96	8
IR maize seeds are expensive	75	4.03	9	87	4.62	9
Weather (rainfall unreliability, cold, drought)	161	3.33	7	147	2.69	4
Farm size	94	3.53	8	80	3.46	7
Land availability	49	4.63	11	55	5.85	10
Lodging	4	2.75	4	31	7.32	12
Weeds, pests and diseases	39	6.56	12	35	6.20	11

N = Number of respondents

Note: The smaller the mean the more important the constraint

Table 5.25. Constraints in application of IR maize technology: Nyanza vs Western farmers

IR maize technology constraints	Nyanza			Western		
	N	Mean	Rank	N	Mean	Rank
Limited accessibility to IR maize kit	320	1.88	1	328	2.10	1
IR maize kit not available	242	2.76	4	268	2.41	2
Very little IR maize supplied	295	2.50	2	332	2.71	3
Very difficult to follow IR maize kit conditions/ guidelines	221	3.40	6	236	3.22	6
Limited information on the technology	218	3.44	7	297	2.91	4
Prefer the traditional methods in controlling *Striga*	125	4.26	8	105	4.12	9
IR maize seeds are expensive	60	4.48	9	102	4.26	11
Weather (rainfall unreliability, cold, drought)	164	2.60	3	144	3.51	7
Farm size	85	2.95	5	89	4.02	8
Land availability	56	6.16	10	48	4.25	10
Lodging	30	7.43	12	5	3.00	5
Weeds, pests and diseases	47	6.62	11	27	6.00	12

N = Number of respondents

Note: The smaller the mean the more important the constraint

A majority of farmers felt that the IR maize seed must be brought into the nearby shops or alternatively increase the kit. A good number as well indicated that there was need for more extension information on the technology as well as demonstrations on how to apply it (Table 5.26). Some felt that when the seed is introduced into the shops, the price should be affordable.

Table 5.26. Farmer recommendations to scale up IR maize technology

Recommendations to scale up IR maize technology	All		Baseline		WeRATE		Nyanza		Western	
	N	%	N	%	N	%	N	%	N	%
Increase IR maize kit	609	73.02	287	76.33	322	70.31	307	76.75	302	69.59
Increase plot size to IR maize	420	50.36	165	43.88	255	55.68	225	56.25	195	44.93
More extension on IR maize technology	531	63.67	222	59.04	309	67.47	238	59.50	293	67.51
Bring the IR maize seed in the nearby shops	648	77.70	261	69.41	387	84.50	314	78.50	334	76.96

N = Number of respondents

Perceptions on characteristics of a good maize stand

Farmers assess crops at various growth stages. Early positive appreciation of a variety in the field can contribute to increased adoption. Farmer perceptions were investigated on what they felt a good maize stand should be with regard to foliage colour, stem thickness, time to tasselling and cob size. Tables 5.27 to 5.30 present the perceptions of the farmers with regard to the various aspects of a good maize stand.

Table 5.27. Characteristics of a good yield maize stand: Leaf foliage colour (% households)

Characteristics of good yield	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
Dark green broad leaves	2.40	1.86	2.84	3.50	1.38
Dark green leaves	82.13	83.51	81.00	76.50	87.33
Dark green many leaves	0.96	1.33	0.66	2.00	–
Dark green one metre long leaves	11.75	10.11	13.10	14.75	8.99
Dark green shiny healthy leaves	1.80	1.33	2.18	3.00	0.69
Dark green thick leaves	0.96	1.86	0.22	0.25	1.61

N = Number of respondents

Table 5.28. Characteristics of a good yield maize stand: Stem thickness (% households)

Characteristics of good yield	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
Big with adventitious roots	1.44	0.80	1.97	2.25	0.69
Big and strong	6.47	2.39	9.83	6.25	6.68
Big and thick	60.67	71.54	51.75	54.50	66.36
Big and long healthy nodes	4.92	1.33	7.86	9.50	0.69
Medium thickness	1.56	1.60	1.53	1.25	1.84
Thick and stout	0.12	0	0.22	0.25	0
Thick and strong	24.82	22.34	26.86	26.00	23.73

N = Number of respondents

Table 5.29. Characteristics of good yield maize stand: Time to tasselling (% households)

Characteristics of good yield	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
Extra early tasselling <45 days	14.03	21.01	8.30	19.00	9.45
Early tasselling <60 days	62.71	61.44	63.76	61.75	63.59
Intermediate tasselling <85 days	8.15	3.46	12.01	6.50	9.68
Late tasselling <95 days	13.43	13.83	13.10	10.50	16.13
Extra late tasselling <110 days	1.68	0.27	2.84	2.25	1.15

N = Number of respondents

Table 5.30. Characteristics of a good yield maize stand: Cob size (% households)

Characteristics of good yield	All	Baseline	WeRATE	Nyanza	Western
N	812	365	447	392	420
Big cobs	39.78	40.27	39.37	42.60	37.14
Big double cobs	5.17	6.03	4.47	7.14	3.33
Big long cobs	9.85	10.96	8.95	2.55	16.67
Double cobs	12.81	15.89	10.29	25.77	0.71
Long cob with many lines	4.80		8.72	1.79	7.62
Long cobs	27.59	26.85	28.19	20.15	34.52

N = Number of respondents

The 'champion maize' farmers dream of should be of dark green leaves, big and thick stem, early tasselling, and big and long cob size.

Factors driving farmer perceptions on IR maize: The probit results

There were 37 independent variables. Out of the 13 nominal variables, only one was significant (at the 5% level). Out of the 24 ordinal variables 9 were significant. The significant variables influencing the perception of households on IR maize appear in Table 5.31 (results for all the variables included in the probit model are shown in Appendix 1).

Table 5.31. Significant factors influencing farmer perceptions on IR maize: Results from the probit analysis

(Y = 1 if IR maize is perceived as highly appropriate; Y = 0 if otherwise)

	Variables	Coefficient	Std Error	b/Std Er	IP[IZI>z]
Number of extension visits per year on improved maize variety	EXTENVIS	-0.0306	0.0126	-2.4220	0.0154
Rank of IR maize package in enhancing maize yield (ranks 1 to 6, where 6>5>4>3>2>1)	LMMYENLS	-0.2587	0.1074	-2.4100	0.0160
Rank of IR maize variety in enhancing maize yield (ranks 1 to 6, where 6>5>4>3>2>1)	MVLMYDLS	0.4024	0.0977	4.1190	0.0000
Rank of IR maize variety on the management costs (ranks 1 to 6, where 6<5<4<3<2<1)	MVLMMCLS	-0.1934	0.0808	-2.3920	0.0167
Rank of IR maize package in *Striga* population reduction (ranks 1 to 6, where 6>5>4>3>2>1)	LMSTPLLS	-0.3798	0.1536	-2.4730	0.0134
Rank of IR maize variety in soil fertility enhancing (ranks 1 to 6, where 6>5>4>3>2>1)	MVLMSFLS	-0.1821	0.0925	-1.9680	0.0491
Rank of IR maize package to withstand other biotic factors (ranks 1 to 6, where 6>5>4>3>2>1)	LMWBFCLS	0.4388	0.1110	3.9550	0.0001
Information sharing about IR maize (1 = yes, 0 = no)	DSHIIOSA	-0.3476	0.1409	-2.4660	0.0136
Category of farmer (1 = Baseline farmer, 0 = WeRATE farmer)	WISDBSD5	-0.3787	0.1589	-2.3830	0.0172
Province (1 = Western, 0 = Nyanza)	PROV	-0.2696	0.1233	-2.1860	0.0288
Constant	Constant	0.7942	0.7799	1.0180	0.3086

The coefficient on the number of visits per year for improved maize varieties had an expected negative sign. The current extension messages focus on other improved varieties. The more the extension messages are on these maize varieties the lesser the attention on IR maize. The need for a balanced message in favour of all the improved varieties would be required for IR maize to spread rapidly. The ranking of IR maize in a package has a negative relationship with the perceived perception while that of IR maize as seed has a positive relationship. The differences in the sign for the two variables would suggest that farmers acknowledge the role of seed in enhancing maize yield and not that of the whole package. This last result is a surprise because the other components of the IR maize package are expected to add on the positive role of the seed. The results on the remaining significant variables are as hypothesised. The positive perception on IR maize is enhanced by its role in reducing the *Striga* population and by having experience with the use of the technology like WeRATE farmers. Farmers also believe that IR maize seed alone cannot enhance soil fertility and that high management cost of IR maize (relative to other modern technologies) reduces the positive perception on this new technology.

Chapter 6
Vulnerability context

Food security situation in western Kenya

Food insecurity is one of the intricate problems facing not only the poor rural households in Sub-Saharan Africa but also the governments and policy makers in the region. A lot of money and painstaking efforts have so far been used to alleviate the problem, yet the calamity lingers on. This situation is no exception to Kenya and the Lake zone.

Food shortage in western Kenya

Results from this survey indicate that a large proportion of farmers in the study area were still experiencing food shortages in their households (Table 6.1). The lowest percentage of households that experienced food shortage in 2005 was observed among WeRATE farmers, which was 72.5%, while the highest was observed among baseline farmers (87.5%). This situation might have been contributed by the role played by the WeRATE consortium in fighting *Striga* infestation, which is a major cause of food shortage in the area. The percentage of food insecure households was higher in Nyanza (nearly 84%) compared to Western (75%) because of the wide range of activities of WeRATE and other NGOs in Western as compared to Nyanza. This explains the devastation of livelihood by *Striga* especially in Nyanza province where there are fewer initiatives to fight *Striga* as compared to Western province.

Table 6.1. Households that experienced food shortage in 2005

	All		Baseline		WeRATE		Nyanza		Western	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Yes	661	79.26	329	87.50	332	72.49	335	83.75	326	75.12
No	173	20.74	47	12.50	126	27.51	65	16.25	108	24.88

Generally, the levels of food insecurity in western Kenya found during this study were at higher levels compared to many rural areas in eastern Africa. Such high food insecurity is common in areas prone to civil wars, severe drought or subjected to any natural or man-made calamities.

The incidences of food shortages in western Kenya seem to reach the peak in April and May and are low from July to October. The months of November to March also register acute food shortages, thus one can conclude that lean months in western Kenya start from November to June of the following year (Figure 1).

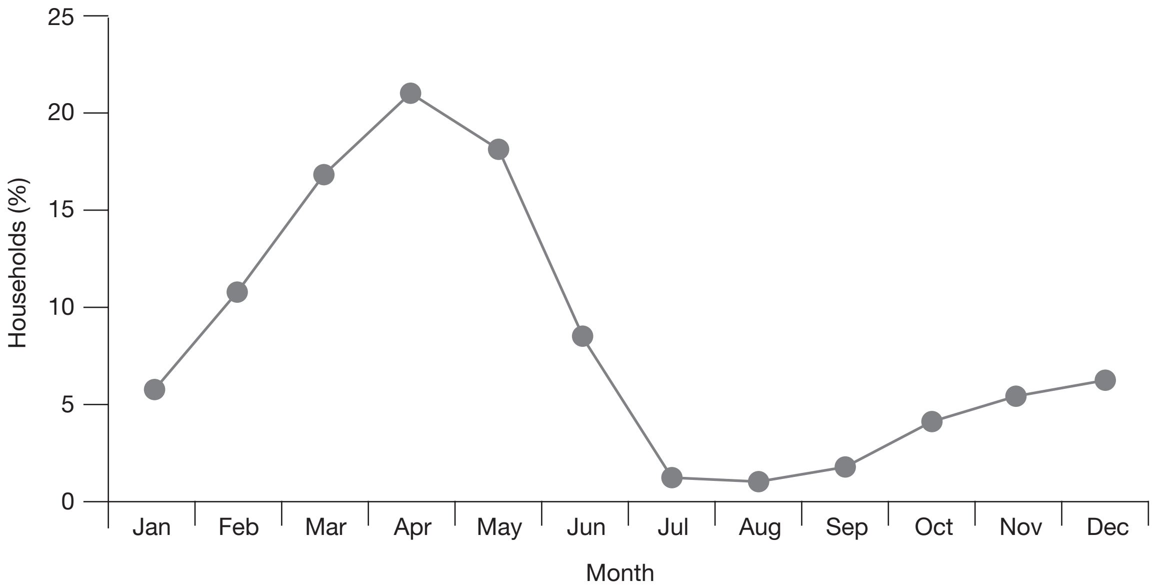

Figure 1. *Food shortage cycle in western Kenya (n = 834)*

Causes of food insecurity in western Kenya

Various reasons can be explained as factors influencing food shortage in the area. The factors range from physical to those edaphically influenced. Incidences of drought that affect both crops and livestock were ranked as the most notorious causes of crop failure hence food insecurity in both provinces. *Striga* infestation, occurrence of flooding and pest infestation (army worms, locusts) were respectively ranked second, third and fourth factors influencing food shortage in the region. Indeed, factors such as low soil fertility, land and labour shortage, and conflicts were also highlighted among the factors that put the area in jeopardy in terms of food security (Table 6.2).

Table 6.2. Causes of food shortage

Causes of food shortage	N	Mean	Rank	SD
Striga infestation to crops	426	2.05	2	0.91
Drought affecting crops and livestock	607	1.92	1	0.92
Pest infestation to crops (army worms, locusts)	340	2.71	4	1.47
Low soil fertility	470	2.78	5	1.20
Land shortage	336	3.12	6	1.49
Labour shortage	224	3.71	7	1.45
Conflict	72	3.71	7	1.20
Flooding	38	2.45	3	1.90

1 = Most important cause; 7 = Least important cause

Further segregation of analysis between baseline and WeRATE farmers showed some resemblance on factors that cause food shortage in western Kenya. Table 6.3 shows that drought that affects crops and livestock and *Striga* infestation were in both groups that gave the stiffest challenges to food security. Baseline farmers perceived flooding as the third threat whereas WeRATE farmers ranked low soil fertility as the third largest menace on food security. Pest infestation was ranked fourth between both groups. Table 6.3 also paints the general picture how baseline and WeRATE farmers perceived causes of food insecurity in their respective households.

Table 6.3. Causes of food shortage: Baseline vs WeRATE farmers

Causes of food shortage	Baseline				WeRATE			
	N	Mean	Rank	SD	N	Mean	Rank	SD
Striga infestation to crops	219	2.02	2	0.98	207	2.08	2	0.83
Drought affecting crops and livestock	302	1.92	1	0.93	305	1.92	1	0.91
Pest infestation to crops (army worms, locusts)	160	2.78	4	1.45	180	2.64	4	1.49
Low soil fertility	226	2.97	5	1.10	244	2.60	3	1.25
Land shortage	148	3.22	6	1.61	188	3.04	6	1.39
Labour shortage	102	3.51	8	1.65	122	3.88	7	1.24
Conflict	33	3.30	7	1.47	39	4.05	8	0.79
Flooding	32	2.34	3	1.94	6	3.00	5	1.67

N = Number of respondents; 1 = Most important cause; 8 = Least important cause

Farmers from Nyanza province perceived threats to food security slightly differently from those of Western province. Nyanza farmers ranked drought as the first cause of food shortage followed by *Striga* infestation, pest infestation and then flooding; Western farmers ranked *Striga* as the most notorious cause to food insecurity trailed by drought, low soil fertility and land shortage (Table 6.4).

Table 6.4. Causes of food shortage: Nyanza vs Western

Causes of food shortage	Nyanza				Western			
	N	Mean	Rank	SD	N	Mean	Rank	SD
Striga infestation to crops	203	2.29	2	0.83	223	1.83	1	0.94
Drought affecting crops and livestock	322	1.83	1	0.94	285	2.03	2	0.89
Pest infestation to crops (army worms, locusts)	187	2.34	3	1.50	153	3.16	6	1.30
Low soil fertility	234	3.00	5	1.26	236	2.57	3	1.10
Land shortage	161	3.44	6	1.48	175	2.83	4	1.44
Labour shortage	125	4.06	8	1.41	99	3.27	7	1.38
Conflict	42	3.95	7	1.23	30	3.37	8	1.10
Flooding	32	2.34	3	1.93	6	3.00	5	1.79

Table 6.5. shows the summary of ranks for causes of food shortage. At all times drought and *Striga* were highly ranked compared to other factors. Such a situation paints a picture of the necessity to combat *Striga* at full force at all times till its disappearance.

Table 6.5. Ranking of causes of food shortage

Causes of food shortage	All	Baseline	WeRATE	Nyanza	Western
Striga infestation to crops	2	2	2	2	1
Drought affecting crops and livestock	1	1	1	1	2
Pest infestation to crops (army worms, locusts)	4	4	4	3	6
Low soil fertility	5	5	3	5	3
Land shortage	6	6	6	6	4
Labour shortage	7	8	7	8	7
Conflict	7	7	8	7	8
Flooding	3	3	5	3	5

Coping strategies for food shortage

In such devastating situations of rampant food insecurity, it is not uncommon for many households to resort to diverse mitigation strategies to arrest the situation. Farmers in western Kenya undertake various strategies to cope with food insecurity. Off-farm employment accounted for higher percentages among other food insecurity mitigation strategies. Formal and informal safety nets and sale of productive household assets also scored high percentages among the coping strategies to food shortage as shown in Table 6.6. An intriguing percentage of households (7.1%) had no other means except

Table 6.6. Coping strategies for food shortage

Coping strategies	Number of counts	Percentage
Nothing but survive on little food	47	7.1*
Formal credit	35	3.4
Informal credit	90	8.8
Formal safety nets	131	12.8
Informal safety nets	217	21.3
Off-farm employment	386	37.8
Sale of productive assets	121	11.9
Petty business	20	2.0
Sale of farm produce	13	1.3
Growing of drought resistant crops	8	0.8
Total	1,068	100.0

* Not included in the total percentage of other coping options

to survive on little food. This represents the most vulnerable group in the study sample. Though it has been said that drought is one of the serious problems in the area, planting of drought resistant crops to fight food insecurity is yet to gain momentum in the region. Only 8% of the studied households considered planting drought resistant crops to fight food shortage (Table 6.6). Sale of farm produce as mitigation strategies was low possibly because of the low farm productivity common to the area.

Effects of food shortage to agricultural production on subsequent years

Food insecurity poses severe implications on agricultural production in the following seasons consequently producing a vicious cycle of hunger and starvation. Households in both Nyanza and Western provinces (64.4%) noticed that the event leads to low agricultural production on subsequent years due to reduced power to purchase inputs. About 35.6% from both provinces lamented that food shortage leads to low agricultural production in the subsequent year(s) because of the reduction in labour power and/or reduced ability of the household to hire labour (Table 6.7). The patterns in Table 6.7 were observed when the analysis was done by geographic region or farmer groups despite changes in the percentages of households.

Table 6.7. Effects of food shortage to agricultural production in subsequent years

	All		Baseline		WeRATE		Nyanza		Western	
Effects of food shortage	N	%	N	%	N	%	N	%	N	%
Low production due to reduced labour power	16	35.56	3	25	13	39.39	11	50	5	21.74
Low production due to reduced purchased inputs	29	64.44	9	75	20	60.61	11	50	18	78.26

Morbidity and mortality

Morbidity status

In medicine, epidemiology and actuarial science, the term morbidity can refer to the state of being diseased (from Latin *morbidus*: sick, unhealthy), the degree or severity of a disease or the prevalence of a disease. It can also refer to the total number of cases in a particular population at a particular point in time, the incidence of a disease, or the number of new cases in a particular population during a particular time interval or disability irrespective of cause, for example disability caused by accident. The term morbidity rate refers either to the incidence rate or to the prevalence rate of a disease.

The study findings show that an average of three members in each household fell sick in the year 2005 for both provinces (834 households). There were more incidences of household members falling sick among WeRATE farmers (average of three members per household for 458 households) than baseline farmers (average of two members per household for 376 households) and a similar trend was observed for the Western province farmers (average of three members per household for 434 households) compared to Nyanza farmers (average of two members per household for 400 households).

Common to countries located in humid tropics, malaria was the most common disease that most household members had suffered from. Malaria accounted for about 46% of all the diseases/infections that the household members in both provinces in the study area suffered from followed by coughing, typhoid, diarrhoea and measles. Other maladies were cold, flu, stomachache and headache (Table 6.8).

Table 6.8. Common diseases/infections in western Kenya

	All		Baseline		WeRATE	
Disease/infection	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Malaria	704	48.55	313	48.91	391	48.45
Coughing	199	13.72	100	15.63	100	12.39
Typhoid	136	9.38	51	7.97	85	10.53
Diarrhoea	101	6.97	38	5.94	63	7.81
Flu	55	3.79	11	1.72	37	4.58
Measles	51	3.52	30	4.69	21	2.60
Cold	48	3.31	21	3.28	27	3.35
Stomachache	23	1.59	9	1.41	14	1.73
Headache	14	0.97	7	1.09	7	0.87
Skin disease	13	0.90	4	0.63	9	1.12
Tuberculosis	13	0.90	9	1.41	4	0.50
Pneumonia	12	0.83	9	1.41	3	0.37
HIV/AIDS	2	0.14	2	0.31	0	–
Others	79	5.45	36	5.63	46	5.70

Mortality rates

In both provinces, the mortality rate was at an average of 1.15 members per household. A few households (6.4%) reported death of at least one member of their household during the year 2005 (Table 6.9). It was once again higher among WeRATE farmers (at an average of 1.19 members per household) compared to baseline farmers (at an average of 1.09 members per household). A similar trend was observed for Western farmers (at an average of 1.09 members per household) compared to their Nyanza counterparts (at an average of 1.22 members per household).

Table 6.9. Number of members of the household who died during year 2005

	All	Baseline	WeRATE	Nyanza	Western
N	53	22	31	24	29
Death	1.15	1.09	1.19	1.22	1.09

N = Number of respondents; It must be noted that it is assumed that human beings can be split into parts

Events of malaria were the major causes of most deaths registered in western Kenya. This was followed by typhoid, HIV/AIDS, diarrhoea and stomach complications. Looking at Figure 2, it is also tempting to surmise that cancer and airborne diseases are also becoming life threatening to many farm families in the area.

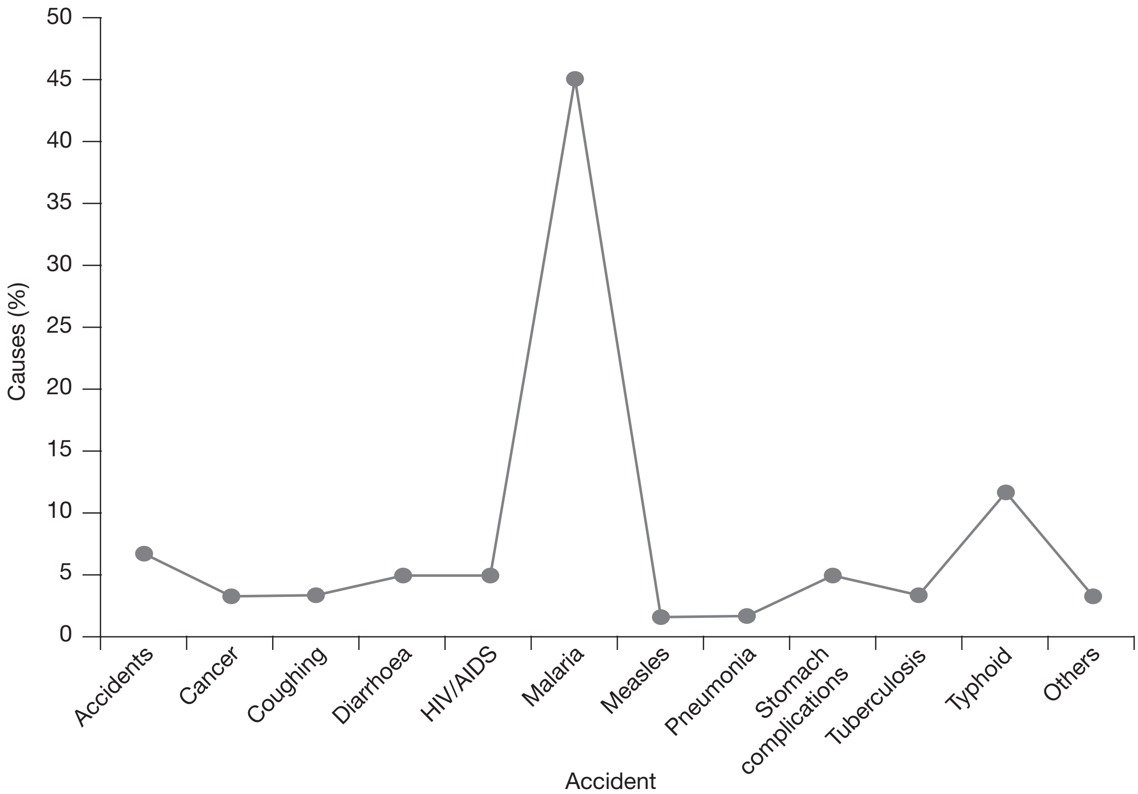

Figure 2. *Causes of deaths in western Kenya (n = 53)*

Anthropometric measurements on vulnerable groups

Z-scores on children aged six years and below

Assessment of the quality of life/livelihoods of a group of people can be determined through various anthropometric measurements. Most widespread indicators for the assessment of the nutritional status of children are Z-scores on weight for height (wasting) or ZWFH, weight for age (underweight) or ZWFA, and height for age (stunting) or ZHFA. These measurements were made for children aged six years old and below in the two provinces and between WeRATE and baseline farmers. The Z values used in the classification of children were as follows: Z >- .00 is normal; -1.00>Z>-2.00 is mild malnutrition; -2.00>Z>-3.00 is moderate malnutrition; and Z<-3.00 is severe malnutrition.

There were a total of 653 children aged six years old and below, out of which 49% were male children. Overall, the nutritional status of children falls under the normal category for the three Z scores though the ZHFA is slightly below the recommended category across the different categories of farmers and regions (Table 6.10). Higher incidences for normal nutritional status for all three indices (ZHFA, ZWFA and ZWFH) were registered among WeRATE than baseline households. The total percentage of children under malnutrition followed the same trends as shown in Tables 6.11 to 6.13.

Table 6.10. Z scores on children aged ≤ 6 years

Categories	All		Baseline		WeRATE		Nyanza		Western	
	N		N		N		N		N	
Z scores height for age (stunting)	640	-1.01	266	-1.10	374	-0.95	262	-0.95	378	-1.06
Z scores weight for age (underweight)	640	-0.41	264	-0.57	376	-0.30	262	-0.35	378	-0.46
Z scores weight for height (wasting)	617	0.09	256	-0.01	361	0.16	254	0.18	363	0.02
Total number of children (aged ≤ 6 years)	653		272		381		269		384	
Male	48.85		47.06		50.13		44.98		51.56	
Female	51.15		52.94		49.87		55.02		48.44	

N = Number of children in analysis

The proportion of children experiencing stunting was as high as 49% for both provinces. It was higher in Western (49%) compared to Nyanza province (48%) (Table 6.11). Higher incidences for underweight and wasting were also higher among children in baseline households than was the case for the children in WeRATE households (Tables 6.12 and 6.13). The three nutritional indices (stunting, underweight and wasting) were also higher among baseline farmers compared to WeRATE farmers. Higher scores of children in underweight could possibly be the consequence of exposure to food insecurity for a short period of time. Children were suffering not only from a short scarcity of food but their long term development was also affected by a chronic exposure to food shortages. This situation of generalised malnutrition of children in regions not affected by civil conflicts is terrifying.

Table 6.11. Z scores on height for age – stunting (% children aged ≤ 6 years)

Nutritional status	All	Baseline	WeRATE	Nyanza	Western
	(640)	(266)	(374)	(262)	(378)
Normal	51.25	49.62	52.41	51.91	50.79
Mild malnutrition	20.94	19.17	22.19	18.32	22.75
Moderate malnutrition	11.56	14.29	9.63	16.03	8.47
Severe malnutrition	16.25	16.92	15.78	13.74	17.99
Total malnutrition	48.75	50.38	47.59	48.09	49.21

Figures in brackets indicate the number of children

Table 6.12. Z scores on weight for age – underweight (% children aged ≤ 6 years)

Nutritional status	All (640)	Baseline (264)	WeRATE (376)	Nyanza (262)	Western (378)
Normal	60.16	58.33	61.44	62.21	58.73
Mild malnutrition	15.31	12.50	17.29	17.18	14.02
Moderate malnutrition	11.88	15.15	9.57	9.92	13.23
Severe malnutrition	12.66	14.02	11.70	10.69	14.02
Total malnutrition	39.84	41.67	38.56	37.79	41.27

Figures in brackets indicate the number of children

Table 6.13. Z scores on weight for height – wasting (% children aged ≤ 6 years)

Nutritional status	All (617)	Baseline (256)	WeRATE (361)	Nyanza (254)	Western (363)
Normal	68.40	65.23	70.64	71.26	66.39
Mild malnutrition	11.18	12.11	10.53	10.24	11.85
Moderate malnutrition	6.81	8.98	5.26	7.48	6.34
Severe malnutrition	13.61	13.67	13.57	11.02	15.43
Total malnutrition	31.60	34.77	29.36	28.74	33.61

Figures in brackets indicate the number of children

Body Mass Index on women

Body Mass Index (BMI) calculates body fat according to the relationship of weight and height. A BMI less than 18.5 is considered a low BMI for most people. A low BMI may indicate underweight and may be associated with health problems. A BMI of 18.5–24.9 is considered good; it may indicate a healthy weight for most people. A BMI of greater than 25 but less than 30 is considered high; it is an indication of overweight and may increase the risk of developing health problems. BMI of more than 30 is considered to be too high and it corresponds to obesity.

For western Kenya, the average BMI score indicates a normal situation for all categories of farmers. A breakdown into BMI classes indicates that only 48% of mothers were in a normal category of BMI; 30% were underweight, about 17% were overweight and 5% were obese (Table 6.14). An analysis on the baseline mothers reveals that 29% fell in the normal category, 48% were underweight, 18% were overweight while 5% were obese. The situation with WeRATE mothers was different with 64% of the mothers falling in the normal category, 15% were underweight, 17% were overweight and 4% were obese. It is evident from the results that the mothers in the WeRATE areas are healthier as compared to those from the baseline areas. The results in Table 6.14 also show that mothers in Western province were better of in terms of nutrition as compared to their counterparts in Nyanza.

Table 6.14. Body Mass Index and BMI groupings of mothers

BMI indices	All (831)	Baseline (379)	WeRATE (452)	Nyanza (391)	Western (440)
Average (%)	22.97	23.08	22.88	22.69	23.22
Underweight (%)	29.7	47.8	14.6	35.0	25.00
Normal (%)	48.1	29.3	63.9	43.7	52.05
Overweight (%)	17.3	17.7	17.0	16.6	17.95
Obese (%)	4.8	5.2	4.4	4.6	5.00

Figures in brackets indicate the number of women

Chapter 7

Institutional issues

Government and Non-Governmental Organisations (NGOs) have always worked towards improving the well being of communities by providing essential services through collaboration or the latter filling in the voids not filled by government. Positive relationships between these institutions can bring about tremendous agricultural sector development. During the perception survey, the respondents were asked about their awareness on the presence of both government and NGOs in their villages and what roles the two played.

Awareness on government activities in the villages

A large number (>70%) of the respondents were aware of government projects in their villages (Table 7.1). Generally, about 80% of all the respondents were aware that the government had at least one project going on in their area. It also emerged that more (83%) of the WeRATE farmers were aware of government presence in terms of projects being undertaken in their respective areas as compared to 78% of the baseline farmers. This as well may imply that WeRATE farmers were well involved in development projects since more development activities were being undertaken by government in their areas compared to those areas of the baseline farmers. It can also be deduced from Table 7.1 that more (86%) Western province respondents were aware of government projects in their areas compared to 74% in Nyanza province.

Table 7.1. Perception on presence of government activities in the villages

Response	All	Baseline	WeRATE	Nyanza	Western
N	834	376	458	400	434
Yes (%)	80.34	77.66	82.53	73.75	86.41
No (%)	19.66	22.34	17.47	26.25	13.59

N = Number of respondents

The respondents pointed out what they considered as positive programmes and services provided by government in their areas. The results in Table 7.2 show the various types of projects sponsored by government. Agriculture comes first. Collectively, agricultural projects which were in form of sponsored farmer field schools, extension service provision, cash crop promotions and support as well as livestock intervention meant a lot to the respondents. The rural communities also perceive road construction as the other important government initiated project. Provision of clean and safe drinking water and improvements in education were also very close to the hearts of the communities. It is important to note that the rural communities recognise and associate the provision and/or improvements in the basic infrastructure (roads, water supply, construction of schools and rural electrification) to government. It is however more important to understand that the respondents also appreciated the input of the government in agriculture.

The respondents from Nyanza province pointed out that the government's presence was highly felt through involvement in agriculture (34%), provision of drinking water (21%), road construction (20%) and provision of health services (9%). Their counterparts from Western province indicated that government was involved in road construction and repairs (27%), agriculture (26.5%), provision of drinking water (21%), improvement in education standards (13%) and provision of health services (8%). It was also evident from the results that different communities appreciate the involvement of government in areas of their greatest needs. A typical example was respondents in Nyanza who were more aware of the government's involvement in provision of drinking water than their counterparts in Western where water was not a major problem.

Table 7.2. Important government initiated projects/services in the villages (% households)

Government projects	All	Nyanza	Western
Agriculture projects (farmer field schools, extension services, cotton, livestock)	29.54	33.79	26.50
Formal safety nets (food for work, *njaa marufuku*)	1.79	4.30	0
Improvement in education standards (building classes, bursary funds)	10.33	6.84	12.83
Provision of clean safe drinking water (spring protection, drilling of wells, water pans)	20.59	20.51	20.64
Provision of health services (construction of clinics, medicine)	8.54	9.38	7.95
Road constructions and repairs	24.17	20.12	27.06
Security	0.08	0	0.14
Youth polytechnics	0.08	0	0.14
Rural electrification	3.91	3.71	4.04
Agro-forestry (tree planting)	0.41	0.20	0.56
Provision of social services (HIV/AIDS)	0.16	0.20	0.14
Administration	0.41	0.98	0.0

Awareness of Non-Governmental Organisations' activities in the villages

As earlier mentioned, NGOs compliment the government in the provision of services to the communities in which they work in. Analysis on presence of NGOs as perceived by the rural communities indicated that most of the respondents (75%) were at least aware of the NGOs involvement in development initiatives in their areas (Table 7.3). This shows that the respondents were more aware of government presence than NGOs. The results also revealed that WeRATE farmers had better perception on the presence of NGOs than baseline farmers. Ninety three percent (93%) of the WeRATE respondents confirmed that NGOs were involved in at least one project in their areas compared to 54% of the baseline farmers. Eighty two percent (82%) of the respondents from Western province pointed out that there were NGOs working on various projects in their areas compared to 67% from Nyanza province.

Table 7.3. Perception on involvement of NGOs in development/service provision

	All	Baseline	WeRATE	Nyanza	Western
Number of respondents	834	376	458	400	434
Yes	75.4	54.3	92.8	67.0	83.2
No	24.6	45.7	7.2	33.0	16.8

There was no major difference in the projects that the NGOs engage in and those that are sponsored by the government. The only difference was in the areas the NGOs target. For instance the government may promote planting of trees aimed at soil erosion conservation. NGOs on the other hand may promote planting of medicinal value trees or at least trees economically beneficial to the communities. In agriculture, the government may target all crops and livestock while NGOs would be more concerned about a few crops and technologies.

Table 7.4. Important projects/services provided by NGOs in Nyanza and Western province (% households)

Projects	All	Nyanza	Western
N	834	400	434
Agricultural activities (inputs, soil fertility, extension, new technologies, livestock)	45.86	41.16	49.83
Agro-forestry (tree planting, seedlings)	1.29	1.00	1.53
Care for orphans	3.04	6.22	0.34
Credit services	0.18	0.20	0.17
Education support	5.71	9.64	2.38
Energy conservation	0.09	0.20	0
Flood control	0.46	1.00	0
Food aid	1.57	1.61	1.53
Health service provision (mobile clinic, care for HIV/AIDS patients)	20.90	15.66	25.34
Provision of clean drinking water	19.71	20.88	18.71
School feeding programme	1.20	2.41	0.17

NGOs in western Kenya were involved in a number of agricultural projects that range from provision of inputs, improvement of soil fertility and promotion of new technologies. The other important projects touched on health and provision of clean and safe drinking water in the communities.

WeRATE farmers benefited more from the NGOs activities in western Kenya than baseline farmers (Table 7.5).

Table 7.5. Important projects/services provided by NGOs: Baseline vs WeRATE farmers (% households)

Projects	Baseline	WeRATE
N	376	458
Agricultural activities (inputs, soil fertility, extension, new technologies, livestock)	38.95	48.44
Agro-forestry (tree planting, seedlings)	4.56	0.13
Care for orphans	4.56	2.50
Credit services	–	0.25
Education support	8.42	4.63
Energy conservation	0.35	–
Flood control	1.75	–
Food aid	–	2.13
Health service provision (mobile clinic, care for HIV/AIDS patients)	22.81	20.03
Provision of clean drinking water	17.89	20.40
School feeding programme	0.35	1.50
Sanitation	0.35	–

Chapter 8
Conclusions and recommendations

The target of this study was to generate data that enabled the identification of important constraints to IR maize technology adoption and assess the extent of use of the IR maize and other *Striga* control technologies based largely on the perception of farmers.

Structured questionnaires were used for data collection. Data were collected in 10 districts, 32 villages and 834 households using multi-stage random sampling strategy. Determination of actual land size accessed by each household was carried out using GPS measurements. Data analyses included descriptive statistics and econometric models. The summary of major findings is as follows.

1. In both provinces and across all categories, households were dominated by male headship, a typical scenario to most households in Sub-Saharan Africa. There were about 24% of households headed by females. The average number of years of schooling among household heads was 4.7 and it was higher in Western province (5.2 years) than in Nyanza province (4.2 years). Respondents other than the household heads registered lower average years of schooling (3.9 years). Households are endowed with a multitude of livelihood capitals. About 83% of household members were members of community groups or associations. Extension agents had visited about 89% of households and about 68% of households had attended field days, seminars and/or agricultural shows. A major part of household income was accrued from the sale of agricultural produce. Thus, interventions that aim at improving the agricultural sector in the region are pertinent.
2. Household land holdings were found to be small. Annual crops especially maize consumed the largest part of household land allocation. This is possibly because maize is the major food crop and a source of cash income to most households. There exists a difference between the information farmers have on the sizes of land they have access to and the reality as established through GPS measurements. Intercropping was a dominant cropping system, which was highly associated with farm risk minimisation.
3. Local varieties, hybrid and OPVs were the three main maize varieties grown by farmers in both provinces. Local maize was the most popular variety. IR maize was also grown in the two provinces though a good number of households were growing it for the first time. Use of inorganic fertiliser was found to be below the recommended rates. Use of organic fertiliser was found to be slightly higher though still not satisfactory given the number of households using it. Maize seeds were over applied in all cases. This scenario, though seen as a caution towards the

fear for pests and diseases as well as the urge to get higher harvests, can only lead to over competition for nutrients, which finally leads to poor harvests.

4. Households perceived *Striga* infestation as the major maize production constraint hence jeopardising the livelihoods of smallholders. Uprooting, burning and manuring are common traditional *Striga* control methods but their effectiveness to control *Striga* is highly questionable. The level of awareness and appropriate use of the alternative modern technologies though still very low is gaining momentum. This calls for more advocacies on appropriate use of modern technologies. All farmers involved in the survey were aware of IR maize technology and about 92% of them were using the technology. The technology was ranked higher in controlling *Striga* population, enhancing maize yield and resisting biotic and abiotic stresses. Extension agents and NGOs were by far the most important sources of information, demonstrators and sources of management knowledge on modern *Striga* control technologies. Gathering more information about modern *Striga* control technologies, lack of improved seed and financial constraints to buy improved seed and other inputs were some of the most important reasons for non-adoption of modern *Striga* control technologies.

5. Extension agents from the Ministry of Agriculture and local NGOs were important in the source of IR maize seed supply, provision of knowledge on management practice for the IR maize technology and promoting awareness on modern *Striga* control technologies. Farmers were introduced to various IR maize technology application guidelines to avoid the negative effect of maize seed coated herbicide (*imazapyr*) on other uncoated seeds. Workshops, farmer exchange visits, extension agents and public *barazas* were utilised as sources of training for use of IR maize technology.

6. Results showed that more than 90% of farmers were aware of the IR maize application guidelines. Washing hands after planting IR maize seed (99.1%) and not planting IR maize in the same hole with legumes (87.1%) were the most understood guidelines followed by application of CAN fertiliser after second weeding (80.6%) and marking an area of 20×20m in severely affected *Striga* field during the last season (79.6%). IR maize guidelines broadcast DAP and UREA across the soil surface and dig into the soil about 15cm (60.5%) and planting legumes before IR maize (41.3%) were the least applied. Though a higher percentage of farmers could read and understood the guidelines accompanying the introduction of IR maize technology, a small percentage of farmers could either read but did not understand or did not read the instructions at all. It was not, however, established if the farmers who did not read the instructions were illiterate or were not given the field-test instructions. It is important to combine both written material and verbal instructions to achieve a higher level of success in delivering the guidelines to the farmers.

7. Extension agents and local NGOs trumpeted demonstrations of IR maize technology use-guidelines followed by research institutes, community based organisations and other minor sources. This gives a positive indication of wide adoption of the technology in the future provided that there will be continued efforts of more extension on appropriate application of the technology. However, various reasons were responsible for non-application of various field instructions such as time consuming/laborious, compromise with indigenous cropping system, and cost implications.

8. Farmer perceptions on productivity of various maize varieties and farm management show that IR maize was generally highly ranked in terms of various agronomic attributes followed by hybrid maize and then local maize. More specifically, IR maize scored higher in terms of *Striga* reduction, soil fertility enhancement, ability to withstand biotic and abiotic stresses, and earliness in maturity. Hybrid maize varieties were best on yield performance and vegetative vigour, whereas local maize varieties performed better on technical simplicity and low management cost. Before harvest, farmers expected IR maize productivity to be 2.44tonnes/ha but actual harvest was 2.59tonnes/ha and 2.68tons/ha for IR maize sole and intercropped respectively. Higher maize yields were observed among Nyanza and WeRATE farmers than was the case for the Western and baseline farmers.

9. A large number of the households aware of various *Striga* control technologies have not yet adopted them. The reasons range from the need to gather more information on the various technologies, approaches to cultural factors, and lack of cash to buy improved seed and other inputs.

10. Farmer perceptions were also measured on farm management implications associated with adoption of IR maize technology. About 27% of the households perceived that the technology would bring land use change whereas 21% surmised it would disperse other crops through changing location of other crops. In terms of social implications of IR maize technology, farmers had the perception that the technology would bring social change such as formation of farmer groups and credit societies through which members could easily access information and support related to improvement of the livelihood of the farm families. A small proportion of households (9%) anticipated that the technology would bring less positive changes due to its high labour requirement hence reduce time for socialisation. The need for careful IR maize seed handling and the feeling of unequal distribution of the IR maize kits were also some of the farmers' feelings towards this technology. However, majority of the households (>95%) approved the technology as highly to moderately appropriate. They suggested ways to scale up the technology, such as increased deployment of the technology to more farming households, identification and use of appropriate distribution channels and more extension on the technology.

11. The farmers in both provinces have been exposed to various *Striga* control technologies for varying years. Most of the farmers interviewed had been exposed to IR maize technology for at least one year while they had been introduced to other modern *Striga* control technologies for more than two years and have been using the traditional methods for more than eleven years. IR maize was generally ranked as the best approach to combat the *Striga* problem followed by the push-pull technology. Traditional practices of manuring, uprooting and burning was ranked third.

12. Analysis on the determinants of perceptions on IR maize revealed that the most important factors that determined the perception, hence the possibility of adoption, were highly related to the variety's ability to withstand biotic factors (pests and diseases), the IR maize yield compared to other varieties traditionally planted/ grown by the farmers, the number of extension visits the farmers received on improved maize technologies, the management cost of the IR maize, the variety's ability to reduce *Striga* population, and sharing of information about IR maize with other farmers outside the study area. It was also revealed that the location in Nyanza province contributes to the positive perception on IR maize. This was based on the needs of Nyanza farmers for this novel technology. This was also true for WeRATE farmers compared to the baseline farmers. It emerged that the longer a farmer was exposed to IR maize the better the perception. Farmers who belonged to groups had better and positive perceptions on IR maize. The ability to enhance the soil fertility was another important factor that affected perceptions on IR maize.

13. Survey results reveal that most households were still highly vulnerable. Food shortage was common to a high proportion of families. About 79% of all surveyed households faced food shortage in 2005. Baseline and Nyanza province households had higher incidences of food shortage compared to WeRATE and Western province households. The peak lean months in the two provinces were April and May and food shortage could last as long as eight months. *Striga* infestation to maize and drought were the two most notorious causes of food shortage in the two provinces. Coping strategies include off-farm short-term jobs, informal and formal safety nets and sale of productive assets. The anthropometric Z scores calculated on children indicate that nearly 49% were stunted, 40% were underweight and 32% were wasting. Similarly, the results on body mass index (BMI) on women showed that 29% were underweight, 17% were overweight and nearly 5% were obese. The extent of the malnutrition on vulnerable groups shown in this study is not common to most countries at peace.

14. Government and Non-Governmental Organisations (NGOs) have always worked towards improving the well-being of the communities by providing essential services through collaborations or the later filling the voids unmet by the former. Households interviewed had a clear perception about the presence of various government and NGO activities in their respective villages. About 80% of the interviewed households acknowledged the presence of various government activities in their areas. Most activities implemented by the government include agricultural projects (farmer field schools, extension services, promotion of cotton and livestock), road constructions and repairs, and provision of clean and safe drinking water. The NGOs were also notable for provision of agricultural projects (input supply, soil fertility management, new technologies, livestock improvement), provision of health services (mobile clinic, care for HIV/AIDS patients), and provision of clean and safe drinking water

This survey has revealed the readiness of hunger stricken poor farm families in the rural areas of Sub-Saharan Africa to adopt improved varieties provided that there is enough information on the crop variety and if the crop offers better alternatives such as improving productivity. The rural communities appreciate the role of the government in providing basic infrastructure and that of NGOs in improving the livelihoods of vulnerable groups. Indeed, the need for government intervention to build infrastructure is also acknowledged in other parts of the globe. Manyong et al (2006), reported that studies from Asia show that returns to investments in infrastructure are always high. In the absence of good infrastructure (road, health, communications) the development of agriculture would never occur adequately. Other policy interventions needed include efficient extension services, and revision of taxes and tariffs on farm products. The need for precise and timely information on new farm technologies is not an overemphasis. Farmers need to be equipped with precise information on market, input supply chains, prices, quality and quantity of the products and other facets required for commercial operation. It is imperative that smallholder farmers get united to attain advantage of new knowledge systems in improved farming practices. Indeed, continued research on how to improve the livelihood of rural farm families and the need to follow the technologies closely is important. Agricultural research can have high payoffs in Africa, but impact depends on how well technology fits with evolving needs and capacity in the agricultural sector and the rest of the economy.

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Appendix 1

Significant factors influencing farmer perceptions on IR maize: Results from the probit analysis

(Y = 1 if IR maize perceived as highly appropriate; Y = 0 if otherwise)

	Variables	Coefficient	Standard Error	Ib/St.Er.	IP[IZI>z]
Perceived yield from IR maize plot in long rainy season 2006 (MT/ha)	VGIRMYEX	-0.0001	0.0003	-0.5170	0.6051
Current yield of IR maize in long rainy season (MT/ha)	LMRIRCUY	0.0000	0.0001	0.5270	0.5985
Yield of IR maize sole stand (MT/ha)	IRYSMH06	-0.0001	0.0003	-0.5320	0.5946
Yield of IR maize intercropped (MT/ha)	IRICHA06	0.0000	0.0003	0.1490	0.8819
Yield of local maize sole stand (MT/ha)	LMSH06	-0.0001	0.0001	-0.9050	0.3656
Yield of local maize intercropped (MT/ha)	LMIH06	0.0001	0.0001	0.4440	0.6569
Yield of hybrid maize sole stand (MT/ha)	HMSH06	-0.0001	0.0002	-0.5580	0.5767
Yield of hybrid maize intercropped (MT/ha)	HMIH06	0.0002	0.0001	1.1330	0.2572
Number of extension visits per year on improved maize variety	EXTENVIS	-0.0306	0.0126	-2.4220	0.0154
Amount of income from maize (2005) (Kshs)	MZINC05	0.0000	0.0000	1.1280	0.2594
Age of respondent (years)	AGRESP	-0.0006	0.0005	-1.1550	0.2481
Years since adoption of IR maize technology	LMRIRYAD	-0.2018	0.1327	-1.5210	0.1283
Size of total land (acres) you have access to	WTFLANAC	0.0047	0.0167	0.2840	0.7767
Category of years of schooling for respondent	YSCHCAT	0.0654	0.0762	0.8590	0.3903
Rank of IR maize package in enhancing maize yield (ranks 1 to 6, where 6>5>4>3>2>1)	LMMYENLS	-0.2587	0.1074	-2.4100	0.0160
Rank of IR maize variety in enhancing maize yield (ranks 1 to 6, where 6>5>4>3>2>1)	MVLMYDLS	0.4024	0.0977	4.1190	0.0000
Rank of IR maize package for technical simplicity (ranks 1 to 6, where 6>5>4>3>2>1)	LMTSIMLS	-0.0355	0.0729	-0.4870	0.6262
Rank of IR maize variety for technical simplicity (ranks 1 to 6, where 6>5>4>3>2>1)	MVLMTSLS	-0.1192	0.0777	-1.5350	0.1247
Rank of IR maize package on the management costs (ranks 1 to 6, where 6<5<4<3<2<1)	LMMGCOLS	0.0990	0.0753	1.3140	0.1887
Rank of IR maize variety on the management costs (ranks 1 to 6, where 6<5<4<3<2<1)	MVLMMCLS	-0.1934	0.0808	-2.3920	0.0167

Rank of IR maize package in *Striga* population reduction (ranks 1 to 6, where 6>5>4>3>2>1)	LMSTPLLS	-0.3798	0.1536	-2.4730	0.0134
Rank of IR maize variety in *Striga* population reduction (ranks 1 to 6, where 6>5>4>3>2>1)	MVLMSPLS	-0.0705	0.1770	-0.3980	0.6904
Rank of IR maize package in soil fertility enhancing (ranks 1 to 6, where 6>5>4>3>2>1)	LMSFERLS	0.0322	0.0786	0.4090	0.6823
Rank of IR maize variety in soil fertility enhancing (ranks 1 to 6, where 6>5>4>3>2>1)	MVLMSFLS	-0.1821	0.0925	-1.9680	0.0491
Rank of IR maize package for vegetative vigour (ranks 1 to 6, where 6>5>4>3>2>1)	LMVGVGLS	-0.0518	0.0909	-0.5690	0.5690
Rank of IR maize variety for vegetative vigour (ranks 1 to 6, where 6>5>4>3>2>1)	MVLMVGLS	0.0911	0.0855	1.0650	0.2870
Rank of IR maize package to withstand abiotic factors (ranks 1 to 6, where 6>5>4>3>2>1)	LMWAFCLS	-0.1043	0.1153	-0.9050	0.3655
Rank of IR maize variety to withstand abiotic (ranks 1 to 6, where 6>5>4>3>2>1)	MVLMAFLS	0.1449	0.1057	1.3710	0.1703
Rank of IR maize package to withstand other biological constraints (ranks 1 to 6, where 6>5>4>3>2>1)	LMWBFCLS	0.4388	0.1110	3.9550	0.0001
Rank of IR maize variety to withstand other biological constraints (ranks 1 to 6, where 6>5>4>3>2>1)	MVLMBFLS	0.1760	0.1005	1.7500	0.0801
Sex of household head (1 = female headed household, 0 = male headed household)	SEXHEAD	-0.1984	0.1190	-1.6670	0.0955
Group membership (1 = belong to group, 0 = does not belong to group)	GROPMEMB	-0.2304	0.1387	-1.6610	0.0967
Information sharing about IR maize (1 = yes, 0 = no)	DSHIIOSA	-0.3476	0.1409	-2.4660	0.0136
Experience of food shortage (1 = yes, 0 = no)	DFOODSLY	-0.0824	0.1362	-0.6040	0.5455
Training about IR maize technology (1 = yes, 0 = no)	DTRIRMBA	0.0004	0.0003	1.1970	0.2315
Category of farmer (1 = baseline farmer, 0 = WeRATE farmer)	WISDBSD5	-0.3787	0.1589	-2.3830	0.0172
Province (1 = Western, 0 = Nyanza)	PROV	-0.2696	0.1233	-2.1860	0.0288
Constant	Constant	0.7942	0.7799	1.0180	0.3086



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