Farmer Strategies for Maize Growing, Maize Streak Virus Disease Control, Weed Management and Feeding of Smallholder Dairy Cattle in Kiambu District, Kenya, 2001-2002

Report of a longitudinal study

Second technical report of DFID project R7955/ZC0180

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Photos on cover:

Left: Stall-fed "Ayrshire" dairy cow at contact farmer's farm in Kamburu

Right: Farmer's field with 100% infection by *Maize Streak Virus* Disease in Kiambu District, short rains 2001.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Executive Summary

- This report describes a longitudinal study of maize growing practices of smallholder farmers in the Kiambu District of the Central Kenyan Highlands between October 2001 and September 2002. It builds on a Rapid Rural Appraisal carried out earlier in May/June 2001 – and it was designed to provide supporting evidence and financial data for a parallel experimental programme. Most important was the use and trading of maize forage and manure and management for control of *Maize streak virus* disease and weeds.

- Eight **farms** were randomly selected in each of the three locations: Kamburu, Kiairia and Muthure. At the start of the study, four farms in each location had livestock and four did not. Up to three maize patches were monitored on each farm. A total of 32 patches were studied in the Short Rains 2001(SR) and 47 in the Long Rains 2002 (LR). Kamburu **farmers** were slightly better off in terms of their farming resources, while those in Kiairia and Muthure were more likely to have other income sources. Mean holding sizes in these three locations were 0.91, 0.57 and 0.25 ha, respectively and, where owned, mean numbers of cattle were 4, 2 and 1.4 per farm, respectively.

- No *Maize streak virus* disease (MSVD) resistant **maize cultivars** were grown and disease resistance did not feature in the reasons why farmers chose specific varieties. The local landrace, Gikuyu, was however grown and in this and other studies of this project, showed some tolerance to MSVD. Hybrids H513 and H614 were not only the most popular cultivars, but also had the highest incidences of MSVD. Prices paid for H614 were 130 KSh/kg in SR and 135 in LR.

- **MSVD** was the most important pest and/or disease problems followed by stem borers. Most significantly given the greater impact of early infection with MSVD on forage and grain yields, 21/32 and 43/47 patches were already infected with MSVD by the normal time of the first weeding, in SR and LR, respectively. Relay and delayed planting may increase MSVD and a wide spread of planting dates was a particular feature in Kamburu. Contrary to expectations therefore, the incidence of MSVD in Kamburu was actually lower than in Kiairia.

- **Stem borers** affected 13/32 and 25/47 patches in SR and LR, respectively.

- **Control of pests and diseases** was rarely carried out except that significant numbers of farmers deliberately fed parts infected with stem borers and MSVD to their animals.

- **Weed management** was of interest not only because of the impact of weeds on yields but also dissemination of seeds of uncontrolled weeds to future crops in both the same patch and to other patches and farms by manure. Observations showed that weed control was failing to prevent seed production – flowering weeds were present at planting as well as at both first and second weedings. At the normal time of the second weeding, weeds were flowering in 20/26 and 18/30 patches in SR and LR, respectively. The second weeding was also often

delayed or not done systematically – weeds either being removed late or only selectively hand-pulled for feeding to livestock. Main weed species in both seasons were *Bidens pilosa*, *Galinsoga parviflora*, *Commelina* spp*.* and *Tagetes minuta.* Flowering weeds of the first three species mentioned and of *Amaranthus* spp. were commonly fed to livestock. Herbicide was used on one patch in SR, but with that exception, almost all patches were hand-weeded, most often by the adult women of the household.

- The use of **manure and fertiliser** was of interest due to the possibilities of (a) dissemination of weed seeds and spores of maize head smut disease in manure and (b) an impact of fertility on weed and disease problems. **Fertiliser** was used in 22/32 and 37/47 patches in SR and LR, respectively. Significant numbers of patches do not, therefore, receive fertiliser. When used and where information was available, mean fertiliser application rates were estimated at (very approximately) 77 kg N/ha and 146 kg P_2O_5/ha. No K_2O was applied. **Manure** was applied to 23/28 patches in SR and 37/43 in LR, 24 of the latter also receiving fertiliser. Surprisingly, 70-80% of patches were manured whether or not the farmers had cattle and the use of fertiliser was actually more likely where farmers had cattle. In terms of risks of disease and weed transmission for which farmers may have no knowledge, the main point was that the manure for 10/32 patches in LR was sourced off-farm. Such patches would warrant more careful monitoring for new weeds and maize head smut.

- **Forages** being fed on farms with livestock at the times of each visit were mainly Napier grass, maize thinnings, green maize stover and banana pseudostems. Farmers with cattle were much more likely to thin their maize patches and it was clear that thinnings were widely used to feed cattle. Forages were sourced on farm 90% of the time but 139 records of off-farm purchases were obtained especially in SR. In four cases roadside grasses were being fed. Maize thinnings and green maize stover were valued from 25-70 KSh and mostly at 50 KSh per "human load", which does not mean that farmers carried these loads (perhaps 40kg) on their backs. Thinnings were sometimes infected with MSVD, but the view of most farmers was that MSVD on the thinnings did ***not*** affect price per human load – (though the number of loads per unit area is likely to be lower). Mean number of human loads of green stover per ha was 137 (on 29 patches), valued at 6877 KSh/ha. Dry stover was fed in 12 cases, yielding from 29-776 human loads per ha.

1. Background and objectives

1.1 Background to the project

This report describes a longitudinal field study of maize growing practices of smallholder farmers as part of a research project investigating the interactions between pests, weeds and foliar diseases of maize and feeding of smallholder dairy cattle in the Central Highlands of Kenya.

The project was sited in Kiambu district, in the heart of the Central Highlands. Much of the district falls within the Nairobi milk shed area, where there is a high demand for milk and a thriving formal and informal milk market. Even where the Nairobi market is inaccessible, milk is consumed in all households that can afford it and there is an active local market in most rural areas.

Maize is the staple food crop and most popular cereal in Kenya and where rainfall permits, farmers grow two crops a year. Dairying is the most important agricultural activity in the Central Highlands after tea and coffee growing (Staal *et al.*, 1997). Dairy animals are kept in "zero-grazed" and "semi-zero grazed systems", housed and fed on cut forage such as Napier grass (*Pennisetum purpureum*), maize forage residues and weeds.

Farming is becoming more intensive as the population grows and land pressure increases. Average farm sizes are small, ranging from 1.1 to 2.0 ha per household (Gitau *et al.*, 1994; Staal *et al.*, 1997). Therefore, producing sufficient forage for dairy cattle is becoming increasingly difficult for farmers. One survey in the Central Highlands highlighted low dry matter intake as one of the most important constraints to dairy production (Omore *et al.*, 1996). Of the land available to dairy farmers, 27 to 50% is occupied with forage and maize. In spite of reducing plot sizes, the area under Napier may be growing (Miano, pers. comm) Forage is scarce during the dry season. One survey showed that dry maize stover accounted for nearly 65% of dry matter intake of dairy cattle during the October dry period (KARI/MoA/ILRI Smallholder Dairy Project). Methu *et al.* (1997) have shown that there is a positive correlation between stover intake and milk yield. Therefore, practices which increase the health and yield of maize, thereby improving the seasonal availability of forage, will increase milk production.

A recent survey of the Central Highlands found that localised, but often severe, epidemics of diseases are present at levels likely to reduce yields (Farrell *et al.*, 1999). They include *Maize streak virus* disease (MSVD), northern leaf blight (*Exserohilum turcicum*), rust (*Puccinia* spp.), anthracnose (*Colletotrichum* spp.), Fusarium foot-rot and stem borer (G. Farrell, KARI/DFID NARP2, Crop Protection Project, pers. comm.). MSVD appears to be the most common and potentially damaging of the diseases in Kiambu District (Njuguna, 1996). It causes yellowing of the leaf, and when it strikes early in the crop's life, can severely stunt or destroy plants. If infection occurs nearer to tasselling, it causes yellowing and may reduce palatability or feed value. McLeod *et al.* (2002) found in the project's Rapid Rural

Appraisal that farmers in Kiambu did not appear to have effective ways of controlling MSVD and they ranked it as the pest/disease with the greatest impact and also the one which was most difficult to control. Weeds infesting maize crops and non-cropped vegetation in adjacent land are potential sources of inoculum (Onudi, 1995). Weeds likewise compete for plant resources and cause 15 - 90% loss in maize yields in Kenya (Maina, 1997). Some weeds of maize are used for forage (Onim et al., 1992) and farmers reputedly delay their second weeding of the maize crop in order to use the weeds as forage. However, Napier and *Desmodium uncinatum*, when grown in association with maize, reduced the incidence of stem borer (*Busseola fusca*) by repelling the adult insects then trapping the larvae (Khan *et al.*, 1997).

While recognising the importance of maize as the staple cereal, many farmers in Kiambu stall-feed dairy cattle and use thinnings and stover to provide about 24% of forage needs (McLeod *et al.*, 2002). Crop protection studies of maize have, however, generally ignored the use of crop residues and thinnings for forage. The project was therefore designed to investigate strategies for control of MSVD, weeds and one other major pest or disease, that are appropriate for such resource poor maize-dairy farmers and which may help to mitigate seasonal forage shortages.

This study follows on from the Rapid Rural Appraisal carried out in May-June 2001, the results of which can be summarised as follows:

1. As previously suspected, forage was in shortest supply in the dry season of January to March each year. The maximum impact of this project on rural livelihoods and on milk yields and quality may therefore come from alleviating forage shortages at this time of year.
2. *Maize streak virus* disease was perceived by farmers to be the main biotic constraint to maize grain and maize forage production in the Kiambu district. Early infection causes total yield loss and necessitates replanting. No information was obtained about the seasonality of the disease. Farmers seemed generally unaware of the epidemiology of the disease and did not know how to control it. The wide range of planting dates and relay cropping may be encouraging disease spread. Resistant cultivars were not generally available in Kenya in 2001. Since the study, however, two varieties, PAN 67 and KH521, have become commercially available in Kiambu district. Other yet more promising cultivars are in the pipeline.
3. The second most important pest/disease of field crops was maize stem borer but control was not perceived to be a serious problem.
4. The maize crop is weeded twice. The first weeding occurs at an early stage of the crop and is vital to prevent competition, while the second weeding may be delayed to allow larger weeds for feeding to livestock. Farmers are well aware of weeds suitable for feeding to their livestock. Although viewed by farmers as important, weeds do not appear to contribute a large volume of forage. At certain times of year there is a heavy labour burden on women, and this appears particularly acute at weeding time and so use of herbicides could be attractive. Equally, a labour-intensive regime for weed control, which imposes

strict rules on timing of use of weeds as forage, would probably not be welcomed.

5. Extension services and women's groups were highlighted as particularly appropriate avenues for dissemination in Kiambu.

1.2 Objectives of the present study

The present study aimed to provide background data against which on-station and on-farm experiments could be placed, in particular:

- deepening knowledge of maize growing practices comparing farmers with and without cattle, including financial aspects;
- learning more about the use and trading of forage and manure;
- investigating seasonality of MSVD under farm conditions;
- investigating weed management and especially to quantify delays in second weeding and use of weeds as forage;
- monitor other agronomic practices and inputs which may have an impact on MSVD and weeds

2. Methods

2.1 Sample of farms

Three communities were studied: Kamburu, Kiairia and Muthure. Kamburu, a tea growing area, was higher and wetter than the other two and rainfall was sufficient for maize to be grown almost continuously. Kiairia was a coffee-growing area, drier than Kamburu and with two clear rainy seasons - short rains (beginning September/October) and long rains (beginning May/June) which delimited the maize cropping seasons. Muthure also had with two clear rainy seasons. It was the closest community to Nairobi and many farmers also grew vegetables for sale.

Eight farms were studied in each community, making a total of 24. Records were kept over two consecutive cropping seasons, namely the short rains season in 2001 and the long rains 2002. When initially selected, there were four farms with cattle and four without in each community although by the time the baseline data were collected, some had acquired cattle (Table 1).

Although variable, mean farm size was greatest in Kamburu and smallest in Muthure (Table 1). Both acres and hectares are shown because Kiambu farmers normally use the acre as a unit, while internationally the hectare is more common.

Table 1. Average farm sizes in study communties

Community	No. of farms	No. of farms with cattle	Mean area acres	Mean area ha	Standard deviation of mean (ha)
Kamburu	8	6	2.22	0.91	0.58
Kiaria	8	5	1.39	0.57	0.61
Muthure	8	5	0.61	0.25	0.16
All	24	16	1.39	0.57	0.55

Each farm might be made up of one or as many as three plots, where a plot was defined as a continuous farmed area. The plot on which the farmhouse was situated was designated the “homestead plot”. Of the 24 study households, four had more than one plot. Each plot was divided into patches on which different crops or combinations of crops were grown. The aim was to study up to three patches on the homestead plot on which maize was grown. If the homestead plot had no maize or was divided into very small patches, another plot would be chosen. Farmers in Kiambu often practice rotation on their patches rather than growing continuous maize, so it was necessary to study a different sample of patches in each season.

Within the chosen plot, up to three patches were chosen. The largest patch with maize was chosen first. If there were more than one maize patch two more were chosen at random. If there were less than three maize patches, another patch with a different crop would be chosen at random. It was not possible to study patches on more than one plot in a single farm because this would have taken too much farmer time.

Table 2. Average patch maize size in study households, long rains season.

Community	No. of patches studied	No. of patches measured	Mean area acres	Mean area ha	Std dev area ha
Kamburu	14	14	0.09	0.037	0.024
Kiaria	19	13	0.10	0.041	0.047
Muthure	14	14	0.06	0.026	0.023
All	47	41	0.08	0.035	0.033

Results are available for 32 and 47 patches of maize in the short and long rains, respectively. Plot sizes were measured in the short rains and patch sizes were measured in 41 patches in long rains only by pacing each side of the patch. The mean patch size was smaller in Muthure than the other two communities but patch sizes showed quite high variability (Table 2).

2.2 Number and timing of visits

The aim was to make four visits to each community, at times approximating to the crop stages of first weeding, second weeding, late tasselling and dry harvest. These times were considered optimum to observe progress of MSV, presence of flowering weeds and use of crop thinnings.

In the short rains, the start of the study was delayed because of the time taken to finalise the questionnaire. Very dry weather meant that in Kamburu and Muthure many farmers harvested crops early, in some cases for forage. In Kamburu and Muthure, two visits were made to each farm, one after the first weeding and one at late tasselling or harvest. In Kiairia three visits were made.

In the long rains, visits were made at or just after first weeding to every patch, at or near tasselling to every patch, and at or just after harvest to 42 of the patches.

2.3 Data collected

Three questionnaires, reproduced in Appendix 2, were administered:

- Baseline: data on household composition, resources owned and farm enterprises. A reduced version of the questionnaire used by the ILRI/KARI Smallholder Dairy Project was used. This was only administered once, at the start of the short rains.
- Plot: data on crops grown and management practices for up to three patches in each farm. This was administered at each visit but the contents of the questionnaire varied with the stage of crop.
- Forage: forages fed on the day of each farm visit. This was administered on each visit.

Two members of the study team, a biologist and a socio-economist, visited each household on each visit to administer the questionnaires and take notes.

3. Results

3.1 Socio-economic characteristics of study households

The majority of households in all communities were male headed (22 out of 24 in total). The mean age of the household's head was 49.8 years, with ages ranging from 34 to 71 years. Most households had about 6 members, with sizes ranging from 4 to 9 and 29% to 100% of household members being adult (over 17 years old).

The majority of households (17/24) had at least one member who had completed secondary school (Table 6). For 5/24 the highest education level was primary school. One household in Kamburu had a University graduate.

Of the 24 households, 13 had medium sized houses (2-3 bedrooms) and 8 of these had timber frames (Table 3). Three households had large houses (>3 bedrooms) with brick walls and eight had small houses (1-2 bedrooms). All had roofs of corrugated iron. One homestead had a separate timber walled building apart from the house in which family members lived while the others had no additional dwellings. All but one farm had electricity. The majority had access to a well or borehole (Table 4) while others had piped water or in one case used a river. Every household owned a wheelbarrow (Table 5) and 11 households owned some other form of wheeled transport in addition, most commonly a bicycle. In Kamburu, one household owned a pickup and another a car. Judged by their houses and transport, Kamburu households were slightly better off than those in the other locations. Kamburu is a wet and fertile area, and tea is currently a profitable crop.

Table 3. House types in study households

	Large	Medium	Small	Total
Community				
Kamburu	2	3	3	8
Kiaria	1	6	1	8
Muthure		4	4	8
All	3	13	8	24

Table 4. Main source of water in study households

Community	Well/ borehole	Piped public water	River/stream	Total
Kamburu	7		1	8
Kiaria	4	4		8
Muthure	8			8
All	19	4	1	24

Table 5. Wheeled transport owned by study farmers

	Number of households owning a....			
Community	Bicycle	Wheelbarrow	Pickup	Car
Kamburu	2	8	1	2
Kiaria	4	8		
Muthure	2	8		
All	8	24	1	2

Sixteen farms owned cattle at the start of the study (Table 6), all of them dairy cattle (exotics or crossbreds). One farm had goats, six had sheep and 15 had poultry, mostly chickens. Two farms owned pigs and two had rabbits. Herd and flock sizes were mostly small (Table 7a), but more cattle were owned by Kamburu households. Although farm sizes in Kamburu were also larger, there was no clear link between farm size and the possession of cattle (Table 7b).

Table 6. Livestock species owned by study farmers

	No. of farms owning species				
Community	Dairy cattle	Goats	Sheep	Poultry	Other
Kamburu	6	1	3	6	1
Kiaria	5	0	3	8	0
Muthure	5	0	0	1	3
All	16	1	6	15	4

Table 7a. Herd and flock sizes on study farms

	Mean no. of animals per farm				
Community	Dairy cattle	Goats	Sheep	Poultry	Other
Kamburu	4.00	2.67	10.00	9.00	4.00
Kiaria	2.00	3.00	8.75		2.00
Muthure	1.40		5.00	2.67	1.40
All	2.56	2.83	9.00	4.25	2.56

Table 7b. Farm sizes and dairy cattle herd sizes on study farms

	Mean number of dairy cattle per farm					
	0	1	2	3	4	6
Mean farm size, ha	0.86	1.12	2.75	0.38	1.62	1.75
Sample size	8	5	5	2	2	2

Table 8 shows non-farm income sources. Eight households had no other source of income by the farm, 16 had one other income source and 3 had two other income sources, making a total of 27 items in the table. More Kamburu households than other were dependent on farm income.

Table 8. Non-farm income generating activities practiced by study households

Community	None	Civil servant	Employee in private business	Regular labourer off farm	Casual labourer off farm	Private business
Kamburu	5	1	1		1	1
Kiaria	2	1	1			4
Muthure	1	3	5	1		
All	8	5	7	1	1	4

3.2 Crop rotations with maize

In the short rains season, 32 maize patches were studied and in the long rains, 47 patches. Information about the previous crop was obtained for 26 patches in the short rains and all 47 in the long rains. Tables 9 and 10 show the crops that were in the study patches in the season before maize, giving an indication of the many crop rotations practised in Kiambu.

Table 9. Crop before the current maize crop, short rains

	Number of patches growing the crop					
Community	Beans	Maize	Napier	Potatoes	Tomato	Total
Kamburu		3		3		6
Kiairia		5	1	3	1	10
Muthure	1	9				10
Grand Total	1	17	1	6	1	26

Table 10. Crop before the current maize crop, long rains

	Number of patches growing the crop							
Community	Beans	Beans + other*	Maize	Maize + other*	Napier	Potatoes	Others**	Total
Kamburu	1			5	1	5	2	14
Kiairia		2	2	7	1	3	4	19
Muthure			4	5		4	1	14
Grand Total	1	2	6	17	2	12	7	47

*Others are potatoes, tomatoes, coffee, beans **Others are cabbage, coffee, capsicum, tomatoes

3.3 Maize intercrops

In the short rains season, 32 maize patches were studied and 26 had one or more intercrops. The most popular were beans and potatoes in different combinations (Table 11). In the long rains, intercrops were grown on 37 of the 47 patches studied. Beans were the most popular crop. They were grown in 27 patches of 37, and in 21 patches beans were the sole intercrop.

Table 11. Intercrops with maize

Community	Beans	Beans Potatoes	Beans Potatoes Peas	Potatoes	Beans coffee	Beans coffee banana	Other
Short rains							
Kamburu	2			1			2
Kiairia	5	2		2			2
Muthure		8	2				
Total	7	10	2	3			4
Others are banana, coffee, Napier, beans+peas							
Long rains							
Kamburu	7			2	1		3
Kiairia	8	3		1		1	1
Muthure	6	1		3			
Total	21	4		6	1	1	4
Others are cabbage, coffee, tomato+banana, sweet potato+capsicum							

3.4 Maize cultivars grown

The combinations of cultivars grown are shown in Tables 12 and 14 and the popularity of different cultivars in Tables 13 and 15. Cultivar was recorded for 31 of a possible 32 patches in the short rains and 46 of 47 in the long rains. In the short rains, seven patches had mixed cultivars. Some were mixed before sowing, others planted in different areas of the same patch. Gikuyu (a local race), H513 and H614 were the most popular. Gikuyu was not grown in Kiairia and H513 was grown on only one patch in Kamburu. In the long rains, five patches were mixed and H614 was the most popular cultivar, followed by local cultivars. No hybrids resistant to MSVD were grown.

Table 12. Number of times each combination of maize cultivars was used, short rains

	Number of plots with cultivar(s)						
Community	Gikuyu	Gikuyu H614	H513	H513 H614 Gikuyu	H614	H627	Others*
Kamburu	3	2	1		3	1	1
Kiairia			2		3	3	2
Muthure	2		4	2			2
Total	5	2	7	2	6	4	5

*Others seen once are H511+H513, H626, H513+H614, Katumani, H513+H614(F2)+Gikuyu

Table 13. Number of times each maize cultivar was used, short rains

	Number of plots with cultivar alone or in combination								
Community	Gikuyu	H511	H513	H614	H614 (F2)	H626	H627	Katu-mani	Total
Kamburu	5		1	5			1	1	13
Kiairia			3	4		1	3		11
Muthure	5	1	8	2	1				17
Total	10	1	12	11	1	1	4	1	41

Table 14. Number of times each combination of maize cultivars was used, long rains

	Number of plots with cultivar(s)						
Community	H513	H614	H625	Local	Local +H513	Other*	Pioneer
Kamburu		4	2	3		4	1
Kiairia	2	8		1	3	3	1
Muthure	3	6		2		3	
Total	5	18	2	6	3	10	2

*Others seen once are Gikuyu, 5243, H626, H627, H628, local+614, local+ 614(F2), local+H626+Pioneer, uncertified from market

Table 15. Number of times each maize cultivar was used, long rains

Community	H513	H614	H625	H626	Local	Pioneer	Total
Kamburu		4	2		4	1	11
Kiairia	5	8		1	5	2	21
Muthure	4	6		1	3		14
Total	9	18	2	2	12	3	46

Gikuyu, 5243, H614(F2), H627, H628, uncertified from market, were used once each

The reasons for choosing different cultivars are shown in Table 16. In the short rains, reasons were given for 41 recorded cultivar choices and in the long rains for 46. The most common reasons were performance related (previous performance, yield of grain, forage or both). Forage yield seemed to be as important as grain yield. Previous experience or seeing the variety in the field seemed to be important although in a small number of cases a recommendation influenced choice. Disease resistance was not specifically mentioned although it may have been part of broad reasons like "performance" or "suitable". It is particularly pertinent to note that resistance to MSVD is not a factor as resistant cultivars were not generally available.

Table 16. Reasons for choosing maize cultivar

Reason for choice	Short rains	Long rains
Cheap	1	3
Drought tolerant	2	2
End of last years bag	3	
Experiment		3
Free gift	4	1
KARI field day		1
Matures fast	1	6
Matures fast. Yield forage		1
Only one available	2	2
Performance for neighbour	3	
Previous performance	13	3
Previous performance. Yield forage		2
Previous season's seed not planted as rain failed	1	
Recommendation - extension		2
Recommendation - seller		1
Seed from shop not good	1	
Spread risk	3	
Suitable	5	2
Yield forage	1	
Yield grain	1	5
Yield grain and forage		12
Total	41	46

Sources of seeds are shown in Tables 17 and 18 and reasons for choice in Tables 19 and 20. The most popular source was recommended stockists or, in Muthure, a mobile van. As suggested previously by choice of cultivar, farmer-grown seed was also popular, particularly in the long rains. Where the reason for the choice of seed source was recorded, reliability was important for commercial stockists (mentioned in association with this were not cheating and authentic seed) and cheapness or previous good performance for home grown seed. In a small number of cases a farmer used seed from another farmer to try it out because they had seen it performing well.

Table 17. Sources of maize seed, short rains. *Note some farmers cited two sources.

Community	Coop-erative	Extension officer	Home grown	Mobile van	Other farmer	Recommended stockist	Relief seed	Total*
Kamburu		2	4		1	4	2	13
Kiairia			1			9		10
Muthure	1		4	4	3	1		13
Total	1	2	9	4	4	14	2	36

Table 18. Sources of maize seed, long rains. *Note some farmers cited two sources.

Community	Coop-erative	Home grown	Market	Mobile van	Other farmer	Recommended stockist	Shop	Total*
Kamburu	1	4			2	4	3	14
Kiairia	1	6	2	3	1	6	2	21
Muthure		6	1	3	1	7		18
Total	2	16	3	6	4	17	5	53

Table 19. Reasons for choosing source of maize seed, short rains

	Coop-erative	Extension officer	Home grown	Mobile van	Other farmer	Rec. stockist
Authentic seed						3
Available	1					1
Buy in bulk & share seed				2		
Cheap			1			
Cost is same as shop				1		
Drought relief		2				
Not in the shop					1	
Performance			1		3	
Reliable				1		8
Stockist seed not good			1			
End of last year's bag			1			
Total	1	2	4	4	4	12

Table 20. Reasons for choosing source of maize seed, long rains

	Co-op	Home grown	Market	Local recycled	Mobile van	Other farmer	Rec. stockist	Shop
Authentic seed							2	
Cheap		3	3	1				
Experiment						2		
Free		2				2		
Grains healthy after harvest		1						
Reliable	1				6		15	5
Sure of the seed		5						
Total	1	11	3	1	6	4	17	5

Where there were records of seed purchased and the amount bought, it was most commonly purchased in 2kg bags (14/23 in the short rains, 28/31 in the long rains), sometimes in 1kg bags (8/23 in the short rains, 1/31 in the long rains), on one occasion in a unit of 0.25kg and twice in a 10kg bag. Prices per kg in the short rains varied from KSh 100/- to 145/-, with a mean of 128/- overall, 128/- for H513 and 130/- for H614. Only one price was recorded for H626 and three for H627. In the

long rains, 19 prices were recorded for H614, from KSh 130/- to 140/ per kg with a mean of KSh 135/-. Two prices were recorded for uncertified seed, KSh 11.5 and KSh 25/-. There were two records of buying Pioneer, both at KSh 177.5.

3.5 Planting practice

Planting date

Late planting of maize can lead to early infection with MSVD. Planting dates for maize were obtained for 25 patches in the short rains and 47 in the long rains. In the short rains, planting tended to be earliest and most spread in Kamburu (Figures 1 and 2). In Muthure all of the planting was done in October and November. In Kiairia, one plot was planted in July and the rest in October and November. In the long rains, most of the patches were planted in March but again, the planting dates tended to be more spread in Kamburu than the other locations. This reflects the fact that there is more continuous rain in this area.

Figure 1. Planting dates for maize, short rains

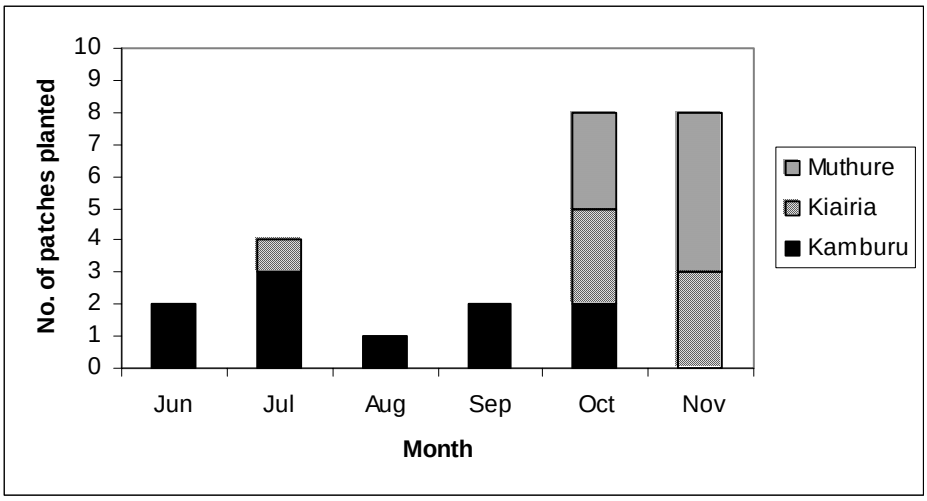
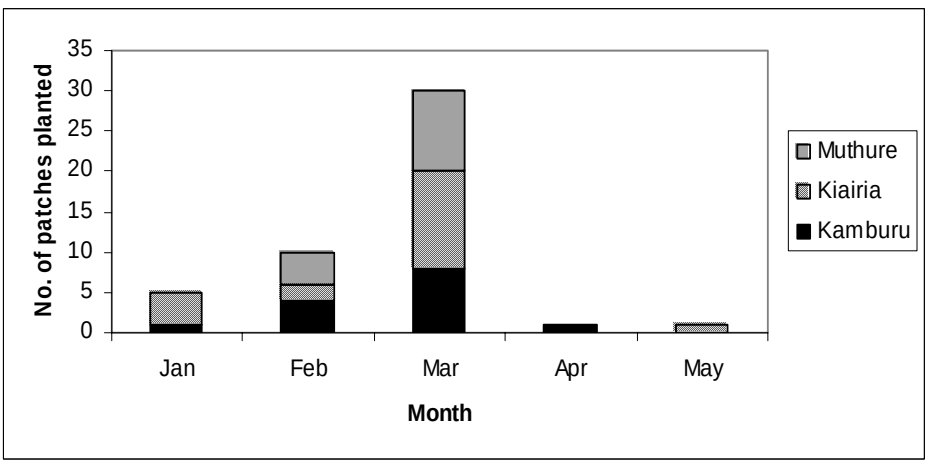


Figure 2. Planting dates for maize, long rains



Planting dates of intercrops depended on the crop. In the short rains potatoes were usually planted before the maize crop, beans and peas most commonly at the same time or within a week afterwards (Table 21). In the long rains (Table 22), potatoes could be planted before, at the same time or after the maize but beans were most commonly planted with the maize crop.

Table 21. Planting dates of maize intercrops, short rains.

	Planting date: weeks relative to maize								
Intercrop	Before*	0	+1	+2	+3	+4	+20	After*	Total
Beans		6	5	1	1	1		2	16
Peas		1	1						2
Potatoes	9		1					1	11
Relay potatoes							1		1
Total	9	7	7	1	1	1	1	3	30

*exact date not given

Table 22. Planting dates of maize intercrops, long rains.

	Planting date: weeks relative to maize							
Intercrop	-1	0	1	2	3	6	9	Total
Beans		17	8		1			26
Potatoes	1	2	1	1				5
Sweet potatoes							1	1
Tomatoes						1		1
Total	1	19	9	1	1	1	1	33

Planting and spacing

In Muthure all maize planting was in hills (Table 23), while in Kamburu and Kiairia it was split fairly evenly between furrows and hills.

Table 23. Planting of maize in hills or furrows

Community	Furrows	Hills	Both	Total
Short rains				
Kamburu	4	7		11
Kiairia	5	5	1	11
Muthure		10		10
Total	9	22	1	32
Long rains				
Kamburu	2	12		14
Kiairia	3	16		19
Muthure		14		14
Total	5	42	47	

A variety of spacing was used (Tables 24 and 25). Spacing between rows tended to be wider when an intercrop was present (Table 26) but the effect on spacing between hills was less clear (Table 27).

Table 24. Spacing of maize at planting, short rains

	Community			
Rows x hills (feet)	Kamburu	Kiairia	Muthure	Total
1.5 x 1		1		1
2 x 1-2	1	3	1	5
2.5 x 1		3	2	5
3 x 1-2	5	4	1	10
4 x 1.5	1			1
Others	2		2	4
Total	11	11	10	32

Table 25. Spacing of maize at planting, long rains

	Community			
Rows x hills (feet)	Kamburu	Kiairia	Muthure	Total
2 x 1-2		7	3	10
2.3 x 1.5		2		2
2.5 x 1-2	6	2		8
2.7 x 1.2			1	1
3.6 x 1.5			2	2
3 x 1-2	2	6	2	10
3 x 3	3			3
4 x 1-2		1	2	3
5 x 1			3	3
6 x 3	2			2
8 x 1.2			1	1
Grand Total	13	18	14	45

Table 26. Space between maize rows in feet, long rains

	<2.5	2.5-3.4	3.5-4.4	4.5+	Total
Intercrop	23%	49%	14%	14%	100%
No intercrop	60%	30%	0%	10%	100%

Table 27. Space between maize hills in feet, long rains

	>1.5	1.5-2.4	2.5-3.4	3.5+	Total
Intercrop	49%	35%	14%	3%	100%
No intercrop	40%	60%	0%	0%	100%

Between one and five seeds were planted in each hill (Tables 28 and 29). In the short rains the most common number was between two and three but in the long rains a number of farmers also planted three to four seeds. It was expected that farmers who had dairy cattle, or adult dairy cows, would plant more seeds per hill with the intention of thinning them for the animals, but this does not seem to have happened. Tables 30 and 31 show the long rains figures, the pattern for the short rains was very similar. On farms where more than one patch was monitored the farmers would sometimes plant an extra seed per hill in one of the patches. It may be that certain patches were designated for feeding to dairy animals, but this practice was observed on farms with and without dairy cattle.

Table 28. Maize seeds per hill, short rains

	Seeds per hill/ station								
Community	**2**	**2 - 3**	**2 – 5**	**3**	**3 - 4**	**3 - 5**	**5**	**many**	**Total**
Kamburu	1	6		1					8
Kiairia	1	3	3		1	1		2	11
Muthure		2		5	1		2		10
Total	2	11	3	6	2	1	2	2	29

Table 29. Maize seeds per hill, long rains

	Seeds per hill/ station						
Community	**2**	**3**	**2 – 3**	**2 - 5**	**3 - 4**	**4 - 5**	**Total**
Kamburu	1	2	7	3	1		14
Kiairia		6	1		12		19
Muthure	2	2	2		7	1	14
Total	3	10	10	3	20	1	47

Table 30. Number of dairy cattle and maize seeds planted per hill, long rains

	No. of patches on farms with this no. of dairy cattle				
Seeds per hill	**0**	**1**	**2**	**3+**	**Total**
2	1	1	1	1	4
2.5		2	3	4	9
3	2	2	2	4	10
3.5+	8	6	5	2	21
Range	3				3
Total	14	11	11	11	47

Table 31. Number of adult dairy cows and maize seeds planted per hill

	No. of patches on farms with this no. of adult dairy cows				
Seeds per hill	**0**	**1**	**2**	**3**	**Total**
2	1	3			4
2.5		6		3	9
3	2	6	2		10
3.5+	10	8	3		21
Range	3				3
Total	16	23	5	3	47

Beans were planted in the maize hill roughly 30% of the time in the short rains and 17% of the time in the long rains. Other crops were nearly always planted separately.

Seed dressing

In the short rains, from a total of 27 responses, 100% of the purely hybrid seed was dressed with Fernisan-D (fungicide and insecticide). The same dressing was used on 50% of the mixed seed and 43% of the purely local seed. In the long rains, from 46 responses, 90% of the purely hybrid seed, 17% of the mixed seed and 50% of the purely local seed were dressed.

Very few farmers used (or thought they were using) dressing against MSVD. In the short rains, of a total of 31 responses, 16% of patches were thought to have been dressed against MSVD. In the long rains, from 47 responses, 17.5% of patches were thought to have been dressed against MSVD.

Fertiliser use

In the short rains, fertiliser was used in 22 out of 32 maize patches. In 21 cases the fertiliser was named (Table 32). DAP (Di-ammonium phosphate: 18:46:0) was most common, used 14 times, in 13 of these alone and once in combination with 20:20:0. CAN (Calcium ammonium nitrate: 26% nitrogen) was used only once, in Muthure. Fertiliser use was reported more often in Kamburu and Kiairia (nine times each) and less in Muthure (four times of which three with a named fertiliser). In the long rains, fertiliser was used in 37 out of 47 patches and named in 31 (Table 33). Again, DAP was the most common. Fertiliser was used on patches with and without intercrops in both seasons (Tables 34 and 35).

Table 32. Use of different types of fertiliser, short rains

	Fertiliser				
Community	**20:20:0**	**CAN**	**DAP**	**DAP + 20:20:0**	**Total**
Kamburu	4		5		9
Kiairia			8	1	9
Muthure	2	1			3
Total	6	1	13	1	21

Table 33. Use of different types of fertiliser, long rains

	Fertiliser						
Community	**20:20:0**	**23:23**	**CAN**	**CAN + DAP**	**DAP**	**DAP + 20:20:0**	**Total**
Kamburu	2		1	1	2	1	7
Kiairia	2	1			9		12
Muthure			2		8	2	12
Total	4	1	3	1	19	3	31

Table 34 Use of fertiliser on different crop combinations, short rains

	Fertiliser						
Maize with:	**CAN**	**DAP**	**DAP + 20:20:0**	**20:20:0**	**Not named**	**None**	**Total**
Beans		4		1		2	7
Beans + Peas		1					1
Beans + Potatoes	1	1	1	2	1	4	10
Beans + Peas + Pot.						2	2
Potatoes		1		1		1	3
Perennial crop		3					3
No intercrop		3		2		1	6
Total	1	13	1	6	1	10	32

Table 35 Use of fertiliser on different crop combinations, long rains

	Fertiliser								
Maize with:	**CAN**	**CAN + DAP**	**DAP**	**DAP + 20:20**	**20:20**	**23:23**	**Not named**	**None**	**Total**
Beans	1	1	10	3	1		1	4	21
Beans + perennial			1				1		2
Beans + potatoes			2		1			1	4
Cabbages							1		1
Perennial crop							1		1
Potatoes			1	1	1		2	1	6
Other		1						1	2
No intercrop	1		4		1	1		3	10
Total	2	2	18	4	4	1	6	10	47

In the short rains, the rate of fertiliser use is not known because the patch sizes were not measured. For 25 patches in the long rains, a mean usage of 0.27 handfuls of fertiliser per maize hill was recorded, ranging from 0.11 to 1. The size of a handful was estimated with the help of nine farmers (men and women) from the Karweti Farmers' Group. The weight of a handful ranged from 32.5 to 61.7 g with a mean of 51.5 g. Another independent assessment gave 60g per handful.

For 16 of the 25 patches it was possible to estimate use per ha (in the others patch dimensions were incomplete). It is emphasised that these estimates are very approximate being based on (a) the calculated (rather than counted) number of hills per patch, (b) an independent measurement of the weight of a handful, i.e. not by the farmer doing the application and (c) the farmers' estimate of the number of maize hills fertilised per handful. Bearing in mind these caveats, complete fertiliser application data for each of these 16 patches may be found in Appendix 1. The mean estimated gross amounts of fertiliser ranged from 253, 401 and 480 kg/ha for handful sizes of 32.5, 51.5 and 61.7 g, respectively. For the mean handful size of 51.5 g, the estimated average across these 16 patches was 77 kg N/ha and 146 kg P_20_5/ha. Although these amounts seem high, total amounts applied per patch only exceeded 20 kg in two cases due to the small patch sizes and the estimated average application per hill in these 16 patches was 11.6 g.

Thirteen farms were recorded as purchasing fertiliser in the short rains, at prices ranging from KSh 21.6 to 37.5 per kg and in quantities ranging from 2kg to 50kg. In the long rains, fertiliser was purchased for 37 patches, at prices ranging from KSh 22 to 30 per kg and in quantities ranging from 1 to 60kg. Tables 36 and 37 show the mean purchase price for different types of fertiliser.

Table 36. Mean fertiliser price, short rains

	Price per kg KSh (no. of purchases)		
Community	CAN	DAP	20:20:00
Kamburu		27.5 (2)	21.8 (2)
Kiairia		36.4 (4)	
Muthure	25.0 (1)		27.5 (2)
Total	25.0 (1)	33.4 (6)	24.7 (4)

Table 37. Mean fertiliser price, long rains

	Price per kg KSh (no. of patches)			
Community	CAN	DAP	20:20:00	23:23
Kamburu		28.1 (6)	24.7 (3)	
Kiairia		26.1 (7)	71.0 (2)	30.0 (1)
Muthure	30.0 (2)	27.3 (3)	30.0 (1)	
Total	30.0 (2)	27.1 (16)	41.0 (6)	30.0 (1)

Manure use

Records about manure use were obtained for 28 patches in the short rains, 23 of which were given manure (Table 38). In the long rains, 32 out of 45 patches for which records were available had manure (Table 39) and 24 patches that had manure were also given fertiliser (Table 40). In both seasons, use of manure was less common in Kamburu than in the other communities.

Table 38. Use of manure, short rains

	Patches given manure			
Community	No record	No	Yes	Total
Kamburu	2	5	4	11
Kiairia	2		9	9
Muthure			10	10
Total	4	5	23	32

Table 39. Use of manure, long rains

	Patches given manure			
Community	No record	No	Yes	Total
Kamburu		7	7	14
Kiairia		5	14	19
Muthure	2	1	11	14
Total	2	13	32	47

Table 40. Use of manure and fertiliser, long rains

	No manure	Manure	Total
No fertiliser		8	8
Fertiliser	11	24	35
Total	11	32	43

Of the 47 patches monitored in the long rains season, 14 were patches from farms that did not have cattle and 33 from farms that did have cattle. Surprisingly, having cattle did not make it more likely that a maize patch would be manured such that between 70-80% of patches were manured regardless of whether the farm had cattle (Table 41). Those on the farms with cattle were more likely to be given fertiliser as well. Of all the 32 manured patches, 22 had manure from the farmer's own farm, four had manure from another farmer in the same community, three from farmers in other communities and three from a trader. Those applying manure obtained from others should be advised to monitor such patches for new weeds and diseases such as maize head smut.

Table 41. Use of manure and fertiliser, long rains

NO CATTLE		No fertiliser	Fertiliser	Grand Total
	No manure	0%	21%	21%
	Manure	29%	50%	79%
Total		29%	71%	14
CATTLE				
	No manure	0%	28%	28%
	Manure	14%	59%	72%
Total		14%	86%	29

3.6 Weeding and weeds

The rationale for looking at weed management in this report was to investigate whether farmers delayed the second weeding in order to feed the larger weeds to their livestock, the extent to which flowering weeds were likely to shed seeds and/or be fed to animals.

Herbicide use

A small amount of pre-emergence herbicide was used on one patch in the short rains. Otherwise all patches were hand-weeded.

Weeds flowering at planting

Only in Muthure were weeds reported flowering at planting. In the short rains they were seen in four out of eight patches. In the long rains they were seen in three patches out of 14. Names of the weeds seen are shown in Table 42.

Table 42. Number of times weeds reported flowering at planting in Muthure

	Short rains	Long rains
Amaranthus spp	4	
Bidens pilosa	5	3
Commelina spp	1	
Ageratum conyzoides		3
Datura stramonium	3	
Emex australis		3
Galinsoga parviflora	4	3
Oxalis latifolia	2	
Oxygonum sinuatum	2	
Portulaca oleracea	1	
Tagetes minuta	2	3
Annual grasses	1	

First weeding

First weeding was done in 28/31 patches in the short rains and 44/47 patches in the long rains. A weeding date or approximate start time was reported in 17 cases in the short rains and 44 cases in the long rains. In the short rains all weeding began between two and four weeks after planting and in the majority of cases three to four weeks after. In the long rains, the majority of weeding was done three to four weeks

after planting, but in three patches it was left for longer and in three it was done after two weeks.

Most of the people involved in weeding were adult women (Tables 43, 44). In Muthure all weeding was done by adult family labour while in Kiairia and Kamburu both children and paid labour were also involved (Tables 43, 44).

Table 43. Who did first weeding, short rains

	Kamburu	Kiairia	Muthure	Total
Children	1	1		2
Family adult female	5	9	9	23
Family adult male	2		1	3
Paid labour female		2		2
Paid labour male		4		4
Paid labour	3			3

Some patches used more than one type of labour

Table 44. Who did first weeding, long rains

	Kamburu	Kiairia	Muthure	Total
Children	4	2		6
Family adult female	9	16	12	37
Family adult male			2	2
Paid labour female	3			3

Some patches used more than one type of labour

In seven cases in the short rains and 17 in the long rains, weeds were reported to be flowering or seeding at the time of first weeding. In the short rains, the largest numbers were reported in Kiairia and the most common flowering/seeding weeds were *Bidens pilosa*, *Commelina* spp. and *Galinsoga parviflora* (Table 45). In the long rains, weed names were not recorded but flowering weeds were seen in all three communities.

Table 45. Number of times weeds reported flowering or seeding at first weeding, short rains

	Kamburu	Kiairia	Muthure	Total
Amaranthus spp.	1		1	2
Bidens pilosa		5	2	7
Conyza bonariensis	1			1
Commelina spp.	1	4	1	6
Cyperus spp.	1	1		2
Digitaria abyssinica		1		1
Galinsoga parviflora	2	5	1	8
Oxalis latifolia		3		3
Oxygonum sinuatum	1	1		2
Tagetes minuta	1	2		3
Total	8	22	5	35

In the short rains, where a first weeding was done, the patch was completed. In the long rains three plots were left partly unweeded.

Second weeding

By the time of second weeding in the short rains, three maize patches had been harvested early and one eaten by porcupines. Data were recorded for 26 patches and data on weeding dates for 22 patches. In Kamburu weeding took place in September, November, December and January. In the other communities it was done in November, December and January. In six patches in Kiairia and three in Muthure there was no real second weeding, but weeds were hand pulled for feeding to animals. In the long rains all 47 patches survived to the second weeding and data were available for all of them. Only 12 were weeded and 6 of these were later than recommended for grain production - more than eight weeks after planting and another was only partly weeded (Table 47). In the remaining 34, the only operation was handpulling for feeding to livestock.

For the patches that were weeded where a weeding date is known, approximate times between planting and weeding varied from only 2 weeks to 21 weeks and there was no obvious clustering (Tables 46 and 47).

Table 46. Weeks between planting and second weeding (approximate), short rains

Weeks	Kamburu	Kiairia	Muthure	Total
4	1		1	2
8			2	2
12			1	1
20	1			1
incomplete data	5	3	3	11
Crop already harvested	2	1		3
Crop eaten by porcupine	1			1
hand pulling*		6	3	9
Total	10	10	10	30

* for feeding to animals

Table 47. Weeks between planting and second weeding (approximate), long rains

Weeks	Kamburu	Kiairia	Muthure	Total
2		1		1
4	1			1
5		1		1
7	1			1
8	1	1		2
9	1			1
10			1	1
13			1	1
14		1		1
16	1			1
21	1			1
no 2nd weeding (handpulling only*)	8	14	12	34
partial 2nd weeding		1		1
Total	14	19	14	47

* for feeding to animals

In the short rains, hired labour was used for weeding only three times out of 11 records. Women and children from the family did the weeding 8/11 times. In the long rains no labour was hired for weeding. Women and/or children from the family did all of the weeding, assisted in one patch by a man from the family.

Weeds were flowering at second weeding time in 20/26 patches in the short rains. In the long rains, 18/30 patches were flowering or seeding. As at the first weeding, the most common flowering/seeding weeds were *Bidens pilosa*, *Commelina* spp. and *Galinsoga parviflora* to which *Amaranthus* spp. could be added (Table 48).

Table 48. Number of times weeds reported flowering or seeding around usual time of second weeding

	Short rains	Long rains
Acanthospermum hispidum	1	
Amaranthus spp.	7	7
Eracustrum arabicum	2	1
(Black jack) *Bidens pilosa*	19	16
Commelina spp.	10	10
Cyperus spp	1	
Emilia discifolia	1	
Emex australis	2	6
Galinsoga parviflora	11	10
Oxalis latifolia	1	
Oxygonum sinuatum	5	1
Sonchus oleraceus	1	
Tagetes minuta	13	11
Annual grasses	4	1
Total	77	62

Weeds flowering at tasselling

In the short rains, weeds were reported flowering on only four patches at tasselling, in three households, all of them in Kamburu. In the long rains 20 patches were reported to have flowering weeds at tasselling.

Use of weeds

In the short rains, weeds from the first weeding were fed to animals from 12/18 patches on 11 farms and not fed from 6/18 patches. In five of these six cases there were no animals on the farm. Not necessarily all of the weeds from each weeding were fed and those that were not fed were left in the field. In the long rains, weeds from four patches where there were animals on the farm were fed to livestock. Otherwise, 65% of the time they were left in the field and for the rest they were put on the compost heap.

In the short rains, there was some contradiction in the data for the second weeding. From the patch data, in six patches weeds were left in the field and in three cases they were reported as fed to animals. From the forage data, ten farms reported feeding weeds to animals. In the long rains the data were more consistent. From the

patch data, in eight cases the weeds were left on the field and in two cases they were put on the compost heap. Weeds from only one patch were fed to animals. The forage data also reported only one case of weeds being fed to animals.

Flowering weeds fed to livestock included *Bidens pilosa*, *Commelina* spp., *Galinsoga parviflora* and *Amaranthus* spp. (Tables 49 and 50). No names were provided of flowering weeds fed to livestock from the first weeding in the long rains. Across the two seasons, there was only one report of a flowering weed at late tasselling and it was not clear whether it was fed to livestock. There was one report of flowering weeds being fed at dry harvest.

Table 49. Flowering weeds from first weeding fed to livestock, short rains

Weed	No. patches from which weeds fed
Amaranthus spp.	2
Bidens pilosa	9
Commelina spp.	7
Conyza bonariensis	1
Cyperus spp	1
Emex australis	2
Galinsoga parviflora	8
Oxalis latifolia	1
Sonchus oleraceus	1
Tagetes minuta	1
Annual grasses	1
Total	34

Table 50. Flowering weeds from second weeding fed to livestock

	No. patches from which weeds fed	
Weed	Short rains	Long rains
Amaranthus spp.	2	4
Bidens pilosa	10	11
Commelina spp.	7	4
Emex australis		2
Galinsoga parviflora	7	8
Tagetes minuta	2	
Annual grasses		
Total	28	32

3.7 Pests and diseases

Pests and diseases seen

In the short rains, at least one pest or disease was reported in 24 patches at or soon after first weeding. In 11 cases, two were reported and in two cases more than two. At second weeding or soon after, 21 patches had a pest or disease. MSVD was the most commonly reported, followed by stem borers (Table 51). In the long rains, 43 patches had at least one pest or disease at or near first weeding and 44 at or near second weeding. Again, MSVD and then stem borers were the most common. Turcicum blight was common at first weeding but then apparently declined (Table 52)

Table 51. Pests and diseases reported in the maize crop, short rains

	Number of affected patches in each community			
Pest/disease at 1st weeding	**Kamburu**	**Kiairia**	**Muthure**	**Total**
MSVD	7	7	7	21
Stemborers	5	3	5	13
Smuts	3		1	4
Turcicum blight	1			1
Cutworms			1	1
Total number of maize patches	**11**	**11**	**10**	**32**
Pest/disease at 2nd weeding				
MSVD	5	7	4	16
Stem borers	4		5	9
Smuts	2		3	5
Rat		1		1
Total number of maize patches	**11**	**11**	**10**	**32**

Table 52. Pests and diseases reported in the maize crop, long rains

	Number of affected patches in each community			
Pest/disease at 1st weeding	**Kamburu**	**Kiairia**	**Muthure**	**Total**
MSVD	10	19	14	43
Stem borers	6	8	3	17
Turcicum blight	5	9	3	17
Grey Leaf Spot	1			1
Total number of maize patches	**14**	**19**	**14**	**47**
Pest/disease at 2nd weeding	**Kamburu**	**Kiairia**	**Muthure**	**Total**
MSVD	12	18	14	44
Stem borers	4	12	9	25
Turcicum blight		2	1	3
Cutworms		2		2
Grey Leaf Spot	2			2
Rust	1			1
Crop dried	1			1
Total number of maize patches	**14**	**19**	**14**	**47**

MSVD incidence

Data on MSVD incidence were collected during the long rains season. "Incidence" was estimated in each patch by examining at least 500 plants in a sample area at the time of the visit and calculating the proportion of plants showing infection. If no plants were removed or thinned out this would show the number of plants infected from emergence to the time of visit. In this study, there were two cases where diseased plants may have been removed and fed to animals, reducing the apparent incidence. As shown in Table 52, 43 plots had been infected by MSVD by the time of the first visit (just after first weeding) and a further plot was infected by the time of the second weeding. Figures 3 and 4 show the percentage of patches at each level of incidence on each visit. The figures show a wide spread in infection levels.

Figure 3. MSVD incidence from planting to first visit, long rains

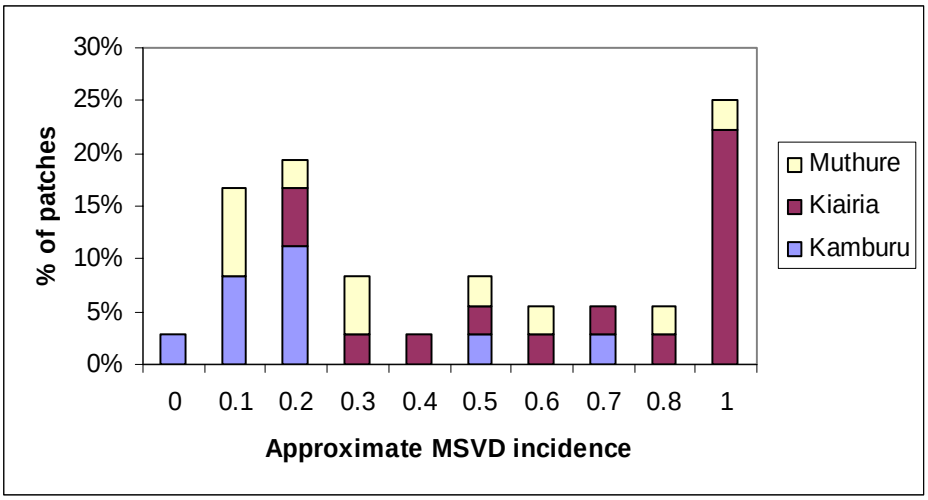


Figure 4. MSVD incidence from planting to second visit, long rains

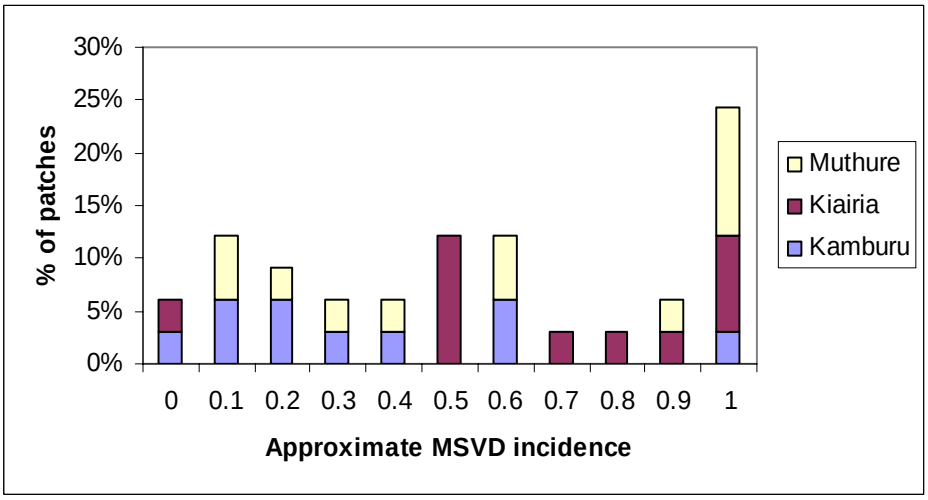


Table 53. MSVD incidence from planting to first weeding in different cultivars, long rains 2002.

Cultivar of maize	Mean MSVD incidence	Minimum MSVD incidence	Maximum MSVD incidence	Sample size*
Local	0.090	0.029	0.15	5
Pioneer	0.168	0.0255	0.31	2
Other hybrid	0.350	0.111	0.49	4
H614	0.522	0.040	0.99	15
H513	0.576	0.190	0.99	5
Local + H series mixed	0.690	0.239	0.99	4

*. Out of 47 patches being monitored, MSVD incidence was not recorded in 11 patches and results are omitted from a further patch where the cultivar was not known or was only grown on one patch.

A higher incidence of MSV infection up to first weeding was seen in the hybrid and mixed cultivars as shown in Table 53, while the local cultivars had very low incidences perhaps implying resistance. Data from on-station trials, described in other project reports, supports this inference of resistance. Seeds from Pioneer also seemed to have low MSVD incidence, but only two values were recorded for it.

Planting date would affect the impact of infection by affecting the stage of crop at which it occurred. There appeared to be a similar spread of dates for the local cultivars and H614. Mixed patches began planting slightly later but about half of them were planted in early March as were the majority of H614 and local cultivars.

Control practices

The most common response to a pest or disease was to do nothing (Tables 53 and 54). With MSVD, the infected plant was sometimes removed and fed to animals.

Table 54. Farmer response to pests and diseases in crop, short rains

Pest/Disease at 1st weeding	Do nothing	Feed whole plant to animals	Feed infected part to animals	Remove infected part and destroy	Remove whole plant and destroy	Other
MSVD	7	1		1		
Smuts	1					1
Stem borers	6					
Total	12	1		1		1
Pest/Disease at 2nd weeding						
MSVD	5		2	1		
Rat	1					
Smuts	3					
Stem borers	6		1		1	
Total	15		3	1	1	

Table 55. Farmer response to pests and diseases in crop, long rains

Pest/disease at 1st weeding	Apply soil	Do nothing	Spray with insecticide	Feed infected part to animals
Blight		14		
MSVD	1	35		6
Grey leaf spot		1		
Stem borers	1	16		
Turcicum blight		3		
Total	2	69		6
Pest/disease at 2nd weeding				
Blight		3		
Cutworms		2		
Grey leaf spot		2		
MSVD		34		6
Rust		1		
Stem borers	1	14	2	6
Total	1	56	2	12

3.8 Feeding

Forages fed

A variety of forages and supplements were fed and records made of *all* those being fed at the time of each visit. Results here are expressed as a percentage of all records at a given visit. These give a snapshot impression the relative frequency of use of different forages although not their quantitative abundance as amounts could not be weighed. At around the first weeding. Napier grass (15% of records), banana pseudostem (12%), maize thinnings (11%) and green maize stover (11%) were fed by the most farmers during the short rains. A wider variety of forages were used during the short rains but during the long rains, Napier was again the most popular forage (41% of records) while roadside grass, bean residue, sweet potato vines and weeds were next most popular (9% each).

Figure 5. Relative frequency of feeding different forages at approx. time of first weeding in short and long rains. Sample sizes were 110 and 22 in short and long rains, respectively. Forages fed rarely are not shown and comprised annual grasses and grass hay, grazed pasture, forage legumes, maize germ, chicken waste.

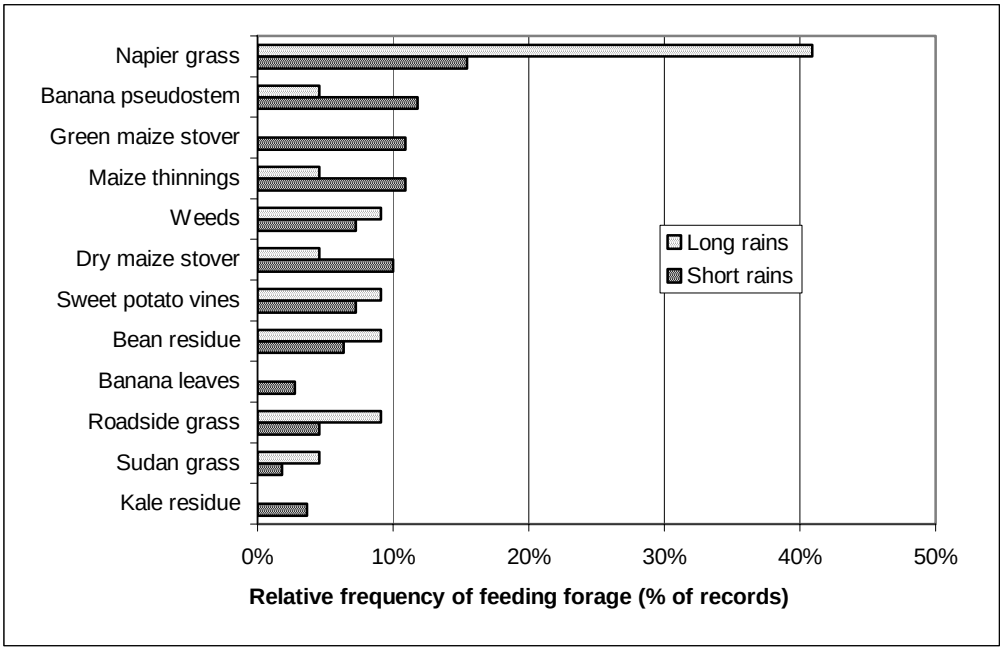


Figure 6 shows equivalent figures for second weeding. Again, Napier was most widely fed in both short and long rains (27% and 29% of records). In the short rains, banana pseudostem (17%), maize thinnings (14%) and green maize stover (11%) were also important. At this time in the long rains, banana pseudostem and weeds were being fed as widely as Napier (29%) and maize thinnings were also important (14%). A much wider range was fed in the short rains.

Figure 7 shows the forages fed during the long season at late tasselling and dry harvest. No comparable data were available for the short rains. The same forages as

before tended to be important, except that no maize thinnings were available at dry harvest.

Figure 6. Relative frequency of use of different forages being fed at approx. time of second weeding in short and long rains. Sample sizes were 64 and 7 in short and long rains, respectively and the latter should therefore be treated with caution. Forages fed rarely (short rains only) are not shown and comprised grass hay, *Hibiscus*, forage legumes, chicken waste.

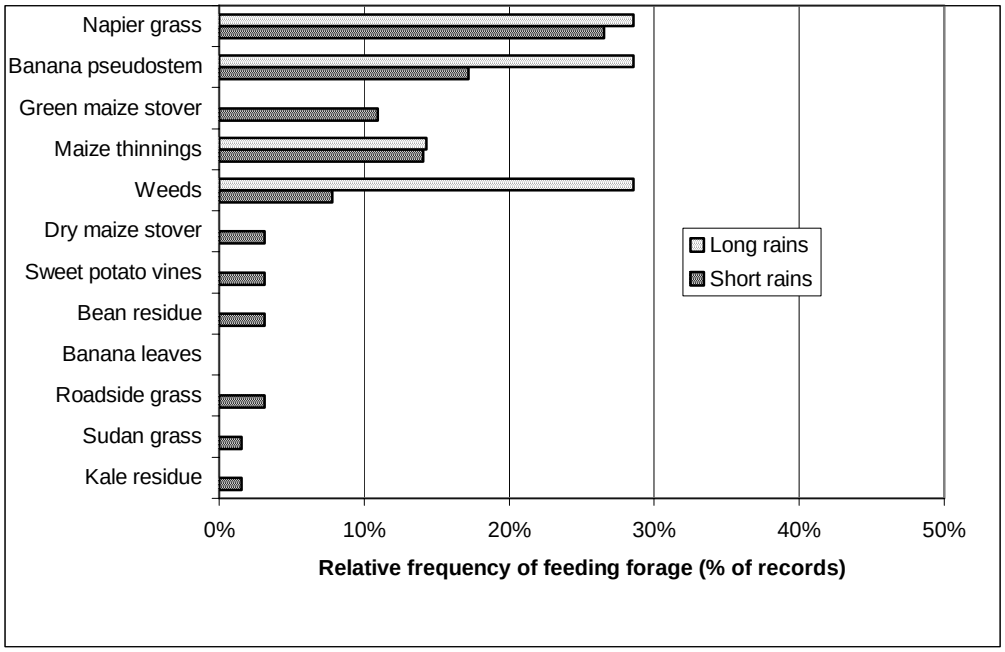
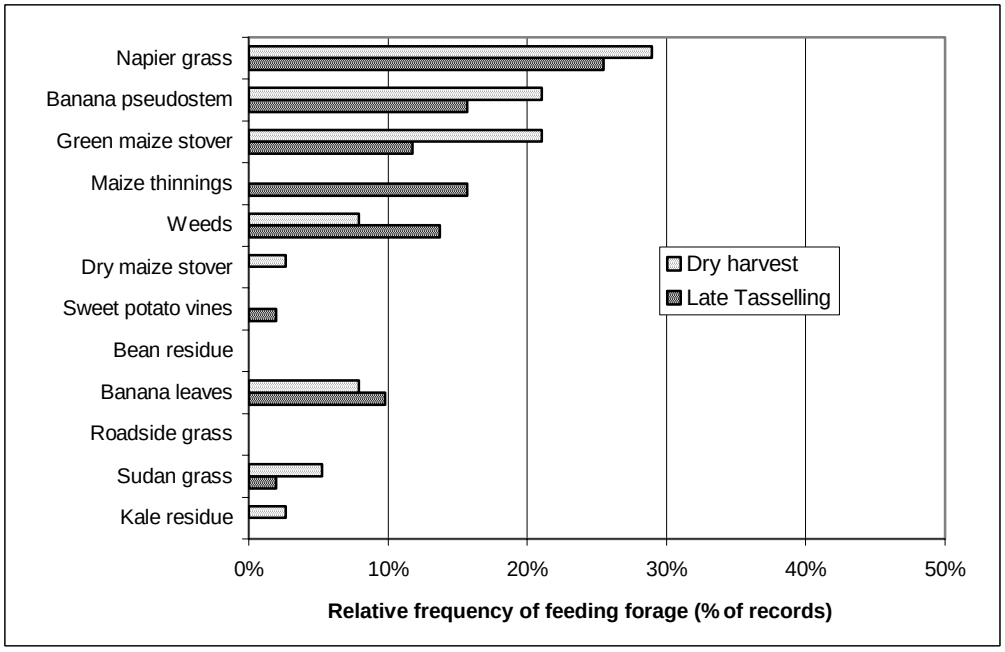


Figure 7. Relative frequencies of feeding different forages approx. at late tasselling and dry harvest in long rains with respective sample sizes of 51 and 38.



The importance of Napier is emphasised by commenting that *all* farmers with livestock were feeding Napier grass to their cattle in the short rains at the times of the first and second weeding and similarly at late tasselling in the long rains. Banana pseudostems were also used as forage by over two thirds of farmers with livestock. Use of maize forage by livestock farmers is described in more detail in section 3.9.

Forage and supplements other than concentrate were produced on the farm 92% of the time in the long rains and 87% in the short rains (there are no records for later tasselling or dry harvest in the short rains season). Table 56 shows the number of times that forage was sourced off the farm. In the short rains, off-farm sourcing was recorded more often and for a greater variety of forages than in the long rains. The only forage sourced from outside the farm but not purchased was roadside grasses. The others were purchased

Table 56. No. of times forage sourced off the farm

Type of forage	Short rains	Long rains
Napier grass	9	6
Banana pseudostem	2	2
Maize thinnings	1	1
Dry maize stover	1	0
Sweet potato vines	1	0
Roadside grass	4	0
Banana leaves	1	0
Total	19	9

Table 57. Prices (KSh) of purchased forages and supplements, short rains

	Mean price for a unit (sample size)							
Forage purchased	16th of acre	40 kg bag	Acre	Human load	Patch	Pick up	Stem	Wheel barrow
Banana pseudostem							29.4 (4)	
Chicken waste		325 (4)						
Dry maize stover				50 (1)				
Grass hay			2000 (2)					
Green maize stover				70 (2)				
Maize germ		600 (1)						
Maize thinnings				40 (2)				
Napier grass	700 (1)			91.5 (10)	1000 (1)	2250 (2)		75 (1)
Roadside grass					200 (1)			
Sweet potato vines				150 (1)				

Maize stover and maize thinnings were purchased by the human load. Napier grass was purchased by the human load, patch, pickup and wheelbarrow. Table 57 shows the units and prices recorded per unit for each feed purchased during the short rains.

In the long rains, prices were obtained for green maize stover 14 times and thinnings 9 times. In all except one case these were based on the farmer's knowledge of the market price rather than an actual purchase. Prices given were the same for stover and thinnings – in 20 cases, KSh 50/- per human load and in 3 cases, KSh 25/ to 50/

per load. For stover, this was slightly lower than the price of KSh 70/- suggested during the short rains.

Effect of disease on forage quality

No MSVD data were available for the short rains season. In the long rains, there was very little information on the level of MSVD infection in forage purchased or sold. However, 23 farmer responses from 11 farmers stated that the price of traded forage was not affected by the extent to which it was infected by MSVD, and no farmer contradicted this.

3.9 Maize stover harvest

Thinning dates

The timing of the first maize thinning was recorded for 15 patches in the short rains and 26 in the long rains. In the short rains data were taken up to the end of January/beginning of February. In the long rains, thinning data were recorded during the visit made between the beginning of August and mid September. 13 patches were never thinned, in one case because the crop died. Of the 33 patches that were thinned, 17 were thinned more or less continuously from between the first and second weeding times until July or August. 10 patches were thinned only between first and second weeding times and six only after the second weeding time.

Thinning started earlier in Kamburu than the other two communities. Thinning was not concentrated into a clearly defined period when all farmers did it, but took place over a period from 2 months (Kamburu in the short rains) to 4 months (Kamburu in the long rains).

Farmers with cattle were more likely to thin maize patches between first and second weeding times (Table 58). Looking at the farm rather than at the patch over the whole long rains season, 16/24 farmers in the study reported thinning and feeding at least one of the maize patches being monitored. Three of these did not have cattle at the beginning of the season and it is assumed they must have acquired them. Of the remaining eight farmers in the study, six did not thin (five of whom did not have cattle), and two thinned for sale only (one with cattle and one without). Farmers with cattle did not necessarily thin all their maize patches and nor did they thin all patches at the same time.

Table 58. Relationship between cattle ownership and thinning maize patches between first and second weeding, long rains.

	Crop dried	Did not thin	Thinned	Total
No cattle	1	9	4	14
Cattle		11	22	33
Total	1	20	26	47

Use of thinnings

In the short rains, all of the available data on use of thinnings came from the second visit to the farms, which was carried out to record information about the second weeding phase of the crop and the period from first to second weeding. No data were recorded at the third visit for thinning between the second weeding and tasselling. In the long rains records were taken at both second and third visits.

The first thinnings harvest was recorded for 16 patches in the short rains. In all cases, they were fed to animals. In the long rains, use of the first thinnings was recorded for 32 patches. In 30 cases they were fed to animals and in two cases they were sold. This information agrees with records on forages fed (Figures 7 and 8) which suggested that thinnings were widely used to feed animals.

In only one case during the short rains were thinnings bought by a study farmer.

There were a few reports of thinnings being sold by other farmers, or by a study farmer at other times. In the short rains prices ranged from KSh 30/- to 100/- per load or KSh 2500/- per acre while during the long rains only the price of KSh 50/- per load was recorded. There was no report of bartering.

In several cases the thinnings were affected by MSVD. The general consensus was that MSVD does not affect the price of thinnings, and only two farmers gave a different opinion. A few farmers commented that the weak and diseased plants were deliberately selected for thinning (therefore, by inference, a buyer would expect that the thinnings might be diseased.) One farmer commented that MSVD seemed to affect milk yield but did not say why, another preferred uninfected stover, and a third did not feed the diseased parts to animals.

Use of green and dry stover

Almost no data on stover harvest was obtained for the short rains crop since many crops were harvested early.

Green stover was harvested from 30 plots in the long rains and in 29 the yield was estimated. Amounts harvested are shown in Table 61. The amount harvested from individual patches ranged from 3.5 to 387.9 human loads per ha. In 22 cases the stover was fed to animals, in 6 cases it was sold, once it was given away and once bartered. In one case it was sold by load at KSh 50/-. The rest of the time it was sold by area (presumably harvested by the person who bought it), and the areas sold were not recorded. The harvest value is estimated here assuming that it could be sold at 50/- at load since this is consistent with the prices reported for thinnings and the one price of 50/- per load reported for stover.

Table 59. Harvest of green stover, long rains

Community	Human loads per ha (sample size)	Value of harvest KSh (at 50/- per load)
Kamburu	93.67 (8)	4684
Kiairia	116.76 (11)	5838
Muthure	191.33 (10)	9567
Total	137.54 (29)	6877

Dry stover was harvested from 17 patches and yields were taken from 15. In 12 cases the stover was given to animals, four times sold and once given away free. Harvested amounts ranged from 29 to 776 human loads per ha, with a mean of 196. No prices were given for dry stover.

3.10 Cob harvest

Almost no data were obtained for this in the short rains since there was a shortage of rain and many crops were harvested before they produced grain.

In the long rains, green cobs were harvested from 31 patches and yields obtained from 28. In three patches only big cobs were harvested, in two only small cobs and in 26 both. Harvested amounts are shown in Table 60.

Table 60. Harvest of green cobs, long rains

		Mean no, of units harvested per ha	
Community	3 tons	Cob	Sack
Kamburu		5683 (7)	
Kiairia		15315 (5)	14.5 (6)
Muthure	40.6 (5)	1640 (3)	59.1 (2)

Dry cobs were harvested from 29 patches and the yield recorded for 23 of them. Harvested amounts are shown in Table 61. No information was recorded about sales or prices.

Table 61. Harvest of dry cobs, long rains

Community	5ton pickup	90kg sack	Debe	sack
Kamburu	11.70 (1)	14.7 (3)	83.3 (1)	64.8 (3)
Kiairia		110.4 (3)		62.3 (5)
Muthure	12.52 (1)	303.2 (2)		28.7 (4)
Grand Total	12.11	122.72	83.33	50.77

4. Discussion and summary

The original random selection in each location of four farms with livestock and four without proved much more variable than expected as several farmers appeared to acquire cattle during the study.

MSVD was the most important pest and/or disease problems followed by stem borers. Control of pests and diseases was however rarely carried out except that some farmers deliberately fed parts infected with stem borers and MSVD to their animals.

Most significantly given the greater impact of early infection with MSVD on forage and grain yields (Murdoch *et al.,* 2003), a majority of patches in both seasons were already infected with MSVD by the normal time of the first weeding. Relay and delayed planting may increase MSVD and a wide spread of planting dates was a particular feature in Kamburu. Contrary to expectations therefore, the incidence of MSVD in Kamburu was actually lower than in Kiairia.

It is striking that no *Maize streak virus* disease (MSVD) resistant cultivars were grown and that disease resistance did not feature in the reasons why farmers chose specific varieties. The local landrace was however clearly well-adapted showing tolerance to MSVD. The potential for alleviation of forage shortages by MSVD control is exemplified by the observation that the Hybrids H513 and H614 were not only the most popular, but also had the highest incidences of MSVD. Farmers were paying dearly for this seed with no resistance to their principal crop protection problem.

Weed management was of interest not only because of the impact of weeds on yields but also dissemination of seeds of uncontrolled weeds to future crops in both the same patch and to other patches and farms by manure. Observations showed that weed control was failing to prevent seed production and the second weeding was also often delayed or not done systematically – weeds either being removed late or only selectively hand-pulled for feeding to livestock. Separate studies in this project have shown that *Amaranthus* seeds can survive rumination and composting (Maina *et al.,* 2003) and this study showed that seeds of *Amaranthus* spp. were being fed to livestock.

The use of manure and fertiliser was of interest due to the possibilities of (a) dissemination of weed seeds and spores of maize head smut disease in manure and (b) an impact of fertility on weed and disease problems. Where used, fertiliser application rates were higher than expected Surprisingly, 70-80% of patches were manured whether or not the farmers had cattle and the use of fertiliser was actually more likely where farmers had cattle. In terms of risks of disease and weed transmission for which farmers may have no knowledge, the main point was that the manure for 10/32 patches in LR was sourced off-farm. Such patches would warrant more careful monitoring for new weeds and maize head smut.

Forages being fed on farms with livestock at the times of each visit were mainly Napier grass, maize thinnings, green maize stover and banana pseudostems. Farmers with cattle were much more likely to thin their maize patches and it was clear that thinnings were widely used to feed cattle. Forages were sourced on farm 90% of the time but 139 records of off-farm purchases were obtained especially in SR. In four cases roadside grasses were being fed. Maize thinnings and green maize stover were valued from 25-70 KSh and mostly at 50 KSh per “human load”. Thinnings were sometimes infected with MSVD, but the view of most farmers was

that MSVD on the thinnings did ***not*** affect price per human load – (though the number of loads per unit area is likely to be lower). Mean number of human loads of green stover per ha was 137 (on 29 patches), valued at 6877 KSh/ha. Dry stover was fed in 12 cases, yielding from 29-776 human loads per ha.

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6. Acknowledgements

This report is an output from research project R7955, IPM of maize forage dairying, funded by DFID Renewable Natural Resources Knowledge Strategy Livestock Production (LPP) and Crop Protection (CPP) programmes for the benefit of developing countries. The views expressed are not necessarily those of DFID.

Our sincere thanks to the Director of KARI, Centre Director and the staff of KARI-NARC-Muguga, KARI-NARL and to ILRI for their support, and extension officers for their help.

Last but not least we are most grateful to the eight farmers in each of the three localities who co-operated so helpfully and without whom this study could not have been fulfilled. The names of the household heads and respondents (where different) are as follows:

Muthure:

Peter Kuheria; Moses Njuguna & Rose Ndeti; John Kamau & Eunice Wanjiru; George Kimani & Edith Wangari; John Mungai Mate & Mary Wairimu; Milical Nyambura; Samuel Muigai & Elizebeth Wanjiru; Peter Waweru Njau.

Kamburu:

Patrick Kimithia Kamau; Wanyoike & Nancy Wanjiru; Joseph Kimani Mbugua; Peter Nduati & Mary Njoki; John Ngubi & Mary Njeri; James Mbugua Njuguna & Serah Njeri; Stephen Kinyanjui & Lydia Kinyanjui; John Mirie;

Kiaria:

Peter Guthundi & Josephine Wambui; Daniel Waitaro & Phyllis Wambui; Alex Njoroge & Joyce Njoroge; John Ndungu & Serah Wambui; George Ngaruiya & Ruth Wanjiku; John Ndicu & Jane Wairimu; Mbugua Gathungu & Agnes Nduta; Daniel Njuguna & Elizabeth Wacege

Appendix 1: Fertiliser application data – long rains

Fertiliser application rates in the long rains can be estimated for 16 patches. Farmers reckoned amounts in number of hills/stations per handful of fertiliser. The number of hills/stations per patch was estimated from the patch dimensions assuming accurate spacing. The amount of fertiliser per handful was 60 g in one assessment and varied from 32.5 to 61.7 g with a mean of 51.5 g in another with nine farmers. Amounts are for total fertiliser used and then separately for N and P_2O_5 (P). No K_2O was applied. Where two fertilisers were used, it was assumed that a 50:50 mix was applied.

Patch *	Patch size ha	Patch size dimension 1 metres (paces)	Patch size dimension 2 metres (paces)	Spacing between rows, feet	Spacing between hills, feet	Seeds per hill	Number of hills dimension 1	Number of rows dimension 2	Number of hills per handful	Fertiliser used (assuming grams per handful) Handfuls per hill	Handfuls per patch	51.5 g kg per patch	32.5 g kg/ha	**51.5 g kg/ha**	61.7 g kg/ha	51.5 kg N /ha	51.5 kg P /ha	Fertiliser types applied
k/7/3	0.024	17	14	4	2	3 to 4	27	11	5	0.2000	59	3.1	81	**129**	154	26	26	20:20
m/2	0.029	21	14	4	1	3	68	11	8 to 10	0.1111	83	4.3	92	**146**	174	28	28	DAP & 20:20
m/1	0.016	13	12	3	1	3	42	13	8 to 10	0.1111	61	3.1	126	**200**	240	38	38	DAP & 20:20
m/3	0.039	39	10	3.6	1.5	3 to 4	85	9	4	0.2500	191	9.8	159	**253**	303	45	116	DAP
k/4/2	0.005	27	2	2.5	1	3 to 4	88	2	5	0.2000	35	1.8	212	**336**	402	60	154	DAP
ku/3	0.022	18	12	2.5	2	2 to 3	29	15	3	0.3333	145	7.5	218	**346**	414	80	80	CAN + DAP
k/7/2	0.025	18	14	3	1	3 to 4	59	15	5	0.2000	177	9.1	228	**362**	433	65	166	DAP
ku/2/1	0.035	16	22	2.5	1	2 - 5	52	28	5	0.2000	291	15.0	269	**426**	510	77	196	DAP
ku/2/2	0.035	16	22	2.5	1	2 - 5	52	28	5	0.2000	291	15.0	269	**426**	510	77	196	DAP
k/4/1	0.141	37	38	2.5	1	3 to 4	121	49	5	0.2000	1186	61.1	274	**434**	520	78	200	DAP
ku/6	0.045	45	10	2.5	1	2 - 5	147	13	5	0.2000	382	19.7	276	**437**	524	79	201	DAP
m/2/2	0.017	12	14	2	1.7	3 to 4	23	22	3 to 4	0.2857	145	7.4	280	**443**	531	80	204	DAP
m/2/3	0.007	5	14	2.7	1.2	3 to 4	13	17	3 to 4	0.2857	63	3.3	293	**465**	557	84	214	DAP
k/3	0.029	21	14	2	1	3 to 4	68	22	5	0.2000	299	15.4	331	**524**	628	94	241	DAP
ku/3/2	0.017	17	10	2.5	1	2 to 3	55	13	3	0.3333	238	12.3	456	**722**	865	130	332	DAP
m/6	0.029	19	15	2	1	2	62	24	3 to 4	0.2857	425	21.9	485	**768**	920	200	0	CAN
													Mean	**253**	**401**	**480**	**77**	**149**	
													Standard deviation	**112**	**178**	**213**	**42**	**93**	
													Minimum	**81**	**129**	**154**	**26**	**0**	
													Maximum	**485**	**768**	**920**	**200**	**332**	

* Patch references give location (k= Kiaria; ku= Kamburu; m=Muthure), and the farm/patch numbers.

Appendix 2: questionnaires

Crop Protection

Longitudinal study

Baseline information to be filled out for EACH FARM

Circle or fill in the appropriate response

Farmer reference No.:

1. Name of Household head: **Date of visit:**

2. Name of respondent: **Gender:**

3. Relationship of respondent to HH head

4. Location of farmstead **Unit:**

Location: **Division:**

5. Name of Enumerator Administering Survey:

6. Give details of all Household members (including HH head) living permanently on the compound and their activities (on and off farm) start with adults

Name	Age (yrs) month)		Sex	Do they contribute to on-farm activities Y/N	Other generating activities	Education level	Class attained	Non-income generating activities

7. Enumerator should observe the house of the household head and note if

Size (large, medium, small) of the main house	Walls (main house)	Roof (main house)	List other HH buildings
Semi-permanent	Bear stone brick Plastered stone bricks Clay brick Mud Timber house Other (specify)	Corrugated iron sheets Tiles Grass Other (specify)	

8. Are there any other houses where members listed as part of the household are living

9. Does the farm have

	Yes/No	Does it work Yes/No
Electricity supplied	N	
A telephone connection		

10. Where does the farm obtain its water, circle all sources

Source	Distance from HH	Use Animal = 1, Crops = 2 ,HH = 3
Piped public water		
River/stream		
Purchased		
Dam		
Other (specify):		

11. Does the farm own transportation facilities: 1= Yes, 2= No
If yes which ones and how many of each (s)

	Transport type	Number		Transport type	Number		Transport type	Number

12. What land do you own (relate back to previous information

• • • Parcel 1 should be where the homestead is situated

	Size (acres)	Distance from HH	Land tenure
1.			
2.			
3.			
4.			

13. What total land size do you farm in acres? { }

How many plots is it divided into? { }

What acreage belongs to you? { }

14. Record the number of animals for the different species kept on the farm

	Cattle		Goats	Sheep	Poultry	Poultry	Poultry	Poultry	Donkeys, horses	Rabbits	Pigs
Animals on farm											
Adult males											
Adult females											
Immature											
Calves/young											
Total											

Codes used in questions

6. ACTIVITY OF ALL HH MEMBERS INCLUDING HH HEAD	EDUCATION LEVEL
0 = None 1 = Civil servant 2 = Employee in private enterprise/driver/business 3 = Labourer off farm regular 4 = Casual labourer during peak periods 5 = Retired with pension 6 = Retired without pension 7 = Private business 8 = Religious leader 9 = In school/college 10= Pre-school age 11= Other (specify)	0 = No formal education 1 = Primary school 2 = Secondary school (O-level) 3 = Post secondary school (A-level) 4 = Technical college (Agri. Teacher's etc) 5 = Adult literacy education 6 = University 7 = Other (specify)
11 FARM TRANSPORT	**12 LAND TENURE**
1 = Bicycle 2 = Wheelbarrow 3 = Handcart 4 = Animal drawn/carried transport 5 = Motorcycle 6 = Tractor 7 = Pick up 8 = Car 9 = Other (specify)	1 = Traditional 2 = Freehold (has title deed) 3 = Rented from another individual 4 = Share cropping 5 = Roadside/Collateral (informally head) 6 = Relative holds freehold 7 = Other (specify)

Crop Protection

Longitudinal survey

Plot information – to be completed over 4 visits for a maximum of 3 identified patches

Farmer reference:

1. **Name of Household head**
2. **Name of respondent**
3. **Name of Enumerator Administering Survey**

Season to which data refer: Long/Short Year

	Date		Date
Visit 1: 1st weeding		**Visit 3: Late tasselling**	
Visit 2: 2nd weeding		**Visit 4: Dry harvest**	

	Patch 1	Patch 2	Patch 3
Plot size (acres) *To be verified*			
AT THE TIME OF PLANTING			
What was the previous crop?			
Was the Previous crop still standing?	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
If previous crop already harvested had residues been removed?	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
Were any weeds flowering/seeding at time of planting?	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
If yes which were the most important FIVE?	**1)** **2)** **3)** **4)** **5)**	**1)** **2)** **3)** **4)** **5)**	**1)** **2)** **3)** **4)** **5)**
PLANTED CROP			
What cultivar of maize did you use?			
Why did you choose this cultivar?			
*****Source of the seed? [1- Home grown, 2-another farmer, 3-recommended stockist, 4-mobile van, 5-co-operative society, ordinary shop, 9-other]**			

*****Why this source? [keep this open ended, use back of sheet for extended answer if needed]**			
*****If bought, what was the price of the seed? Unit [ ]** **Price [ ]**			
Was the seed dressed?	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
Was seed dressed for MSV?	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
When did you plant the maize (Give date)			
What other crops were planted with the maize (intercropped)	**1)** **2)** **3)**	**1)** **2)** **3)**	**1)** **2)** **3)**
What dates were the intercrops planted **(*If more than one intercrop, ensure they are numbered as above)***	**1)** **2)** **3)**	**1)** **2)** **3)**	**1)** **2)** **3)**
HOW WERE THE CROPS PLANTED			
Was maize planted in hills or furrows?			
What was the spacing between rows?			
What was the spacing between hills/stations			
How many seeds per hill/station?			
How much seed was used for the whole patch? **See codes for units**	**Unit [ ]** **No. of units [ ]**	**Unit [ ]** **No. of units [ ]**	**Unit [ ]** **No. of units [ ]**
Were the intercrop seeds placed in the same hill as the maize seeds? **(*If more than one intercrop, ensure they are numbered as above)***	**1)** **2)** **3)**	**1)** **2)** **3)**	**1)** **2)** **3)**
What was the spacing between rows for the intercrop? **(*If more than one intercrop, ensure they are numbered as above)***	**1)** **2)** **3)**	**1)** **2)** **3)**	**1)** **2)** **3)**
What was the spacing between hill/stations for the intercrop? ***(If more than one intercrop, ensure they are numbered as above)***	**1)** **2)** **3)**	**1)** **2)** **3)**	**1)** **2)** **3)**
Was fertilizer used	**[Yes/No)**	**[Yes/No)**	**[Yes/No)**

If yes, which type of fertilizer **See codes for type**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**
*****Source and price of fertilizers** **[Source codes: 1=left over from previous use, 2=another farmer, 3=recommended stockist, 4=mobile van, 5=co-operative society, ordinary shop, 9=other]**	**Type [ ] Source [ ] Amount bought [ ] Price KSh [ ]** **Type [ ] Source [ ] Amount bought [ ] Price KSh [ ]** **Type [ ] Source [ ] Amount bought [ ] Price KSh [ ]** **Type [ ] Source [ ] Amount bought [ ] Price KSh [ ]** **Type [ ] Source [ ] Amount bought [ ] Price KSh [ ]**		
How much fertilizer was used on the whole patch? **See codes for units**	**Unit [ ]** **No. of units [ ]**	**Unit [ ]** **No. of units[ ]**	**Unit [ ]** **No. of units[ ]**
Was manure used	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
How much manure was used on the whole patch? **See codes for units**	**Unit [ ]** **No. of units [ ]**	**Unit [ ]** **No. of units [ ]**	**Unit [ ]** **No. of units [ ]**
*****Source and price of manure [Source Codes: 1=own farm, 2=farmer in same community, 3=farmer in another community, 9=other]**	**Source [ ] Amount bought [ ] Price Ksh [ ]** **If source 3, distance to seller [ ]**		
Was herbicide used	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
If yes, which type of herbicide **See codes for type**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**
*****Source and price of herbicides [Source Codes: 1=left over from previous use, 2=another farmer, 3=recommended stockist, 4=mobile van, 5=co-operative society, ordinary shop, 9=other]**	**Type [ ] Source [ ] Amount bought [ ] Price KSh [ ]** **Type [ ] Source [ ] Amount bought [ ] Price KSh [ ]** **Type [ ] Source [ ] Amount bought [ ] Price KSh [ ]**		
How much herbicide was used on the whole patch? **See codes for units**	**Unit [ ]** **No. of units [ ]**	**Unit [ ]** **No. of units [ ]**	**Unit [ ]** **No. of units [ ]**
AT FIRST WEEDING			
Was a 1st weeding carried out approx 2 weeks post planting	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
Date at start of first weeding?			
Who did weeding? **See codes for who did the weeding**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**
What did they do with the weeds? **See codes for what they did with the weeds**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**
Were any weeds flowering/ seeding at time of first weeding?	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
If yes which were the most important	**1)** **2)**	**1)** **2)**	**1)** **2)**

	3) 4) 5)	3) 4) 5)	3) 4) 5)
List diseases or pests noted in the maize **See codes for pests**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**
What disease control practices were carried out? **See codes for control**			

VISIT 2: AT 2nd WEEDING			
Date 1st weeding finished			
Was whole plot completed?	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
If no, what % was left unweeded			
Why was weeding not completed? **See codes for reasons**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**
Were any weeds flowering /seeding at time of second weeding?	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
If yes which were the most important FIVE?	**1)** **2)** **3)** **4)** **5)**	**1)** **2)** **3)** **4)** **5)**	**1)** **2)** **3)** **4)** **5)**
List diseases or pests noted in the maize **See codes for pests**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**
What disease control practices were carried out? **See codes for control**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**
Has the maize been thinned since the last visit?	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
If yes, dates of thinning			
What did you do with thinning? **See codes for what done; note one extra code has been added**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**
******If sold or bartered, to whom (1=farmer in same community, farmer in another community; 9=other)**			
******If sold or bartered, for what price? [note this spans all 3 boxes]**	**Amount sold [ ] Price [ ]** **Amount bartered [ ] For what [ ]**		
Were the thinnings affected by MSV or any other disease?	**MSV [ ] Blight [ ] Other (Specify) [ ]**		
Did the quality affect what you decided to do with the thinnings or the price you were able to get for them?			

VISIT 3: LATE TASSELLING			
Has the maize been thinned since the last visit?	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
If yes, dates if thinning			
What did you do with thinnings? **See codes for what done**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**
******If sold or bartered, to whom(1=farmer in the same community; farmer in other community; 9=other)**			
******If sold or bartered, for what price? [Note this spans all 3 boxes]**	**Amount sold [ ] Price [ ]** **Amount bartered [ ] For what [ ]**		
******Were the thinnings affected by MSV or any other disease?**	**MSV [ ] Blight [ ] Other(specify) [ ]**		
Did the quality affect what you decided to do with the thinnings or the price you were able to get for them?			
Are any weeds flowering/seeding at present	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
If yes, which were the most important FIVE?	**1)** **2)** **3)** **4)** **5)**	**1)** **2)** **3)** **4)** **5)**	**1)** **2)** **3)** **4)** **5)**

VISIT 4: AT DRY HARVEST			
Were any cobs harvested green?	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
If yes, were they big or small	**[Big/small]**	**[Big/small]**	**[Big/small]**
What was the yield of green cobs? **See codes for units**	**Unit [ ]** **No. of units [ ]**	**Unit [ ]** **No. of units [ ]**	**Unit [ ]** **No. of units [ ]**
Were any dry cobs harvested	**[Yes/No]**	**[Yes/No]**	**[Yes/No]**
If yes, how were they harvested **See codes for harvest method**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**	**[ ] [ ] [ ]**
******What was done with the green stover? [1=fed to animals; [put on compost heap; 3=sold; 4=bartered; 9=other]**			

******If green stover sold or bartered, for what price? [note this spans all 3 boxes]**	**Unit [ ] Kgs/unit [ ] Price/unit [ ] Total units sold [ ]** **Amount bartered [ ] For what [ ]**		
*****Was the green stover affected by MSV or any other disease?**	**MSV [ ] Blight [ ] Other (Specify) [ ]**		
******Did the quality affect what you decided to do with the stover of the price you were able to get for it?**			
******What was done with the dry stover? [1=fed to animals; put on compost heap; 3=sold; 4=bartered; 9=other]**			
******If dry stover sold or bartered, for what price? [note this spans all 3 boxes]**	**Unit [ ] Kgs/unit [ ] Price/unit [ ] Total units sold [ ]**		
*****Was the dry stover affected by MSV or any other disease?**	**MSV [ ] Blight [ ] Other (Specify) [ ]**		
******Did the quality affect what you decided to do with the stover or the price you were able to get it**			

Question codes

Seed units **1=2kg bag** **2=10 kg bag** **3= 1 kasuku tin** **4= 2 kg kasuku tin** **5= Other (specify)**	**Fertilizer type** **1= CAN** **2= DAP** **3= 20:20:0** **4= 17:17:0** **5= 23:23** **6= Other, specify**	**Fertilizer units** **1= 50 kg sack** **2= 10 kg sack** **3= kgs** **4= Other, specify**	**Manure units** **1= wheelbarrow** **2= debe** **3= 70 kg sacks** **4= 50 kg sack** **5= 3 ton pick up** **6= 5 ton pick up** **7= other (specify)**
Herbicide type **1= Lasso A trazine** **2= Lasso + Linuron** **3= Round up** **4= Other (specify)**	Herbicide units	**Who did weeding** **1= Female paid labourer** **2= Male paid labourer** **3= Family female>18 yrs** **4= Family male >18 yrs** **5= Children < 18 yrs**	**What done with weeds** **1= Leave where cut** **2= Put on compost heap** **3= Sold** **4= Bartered** **4= Other (Specify)**
Pest **1= MSV** **2= Smuts** **3= Blight** **4= Aphids** **5= Cutworms** **6= Stem borer** **7= Other (specify)**	**Disease/pest control** **1= Removal of infected plant parts and destroy** **2= Removal of whole plant and destroy** **3= Removal of infected plant parts and feed to animals** **4= Removal of whole plant and feed animals** **5= Spray with insecticide** **6= Do nothing** **7= Other (specify)** **8= Other (specify)** **9= Other (specify)**	**Reasons for not completing first weeding** **1= Shortage of labour** **2= Lack of cash to pay labour** **3= Children back to school** **4= Sickness** **5= Other (specify)**	**Use of thinnings** **1= Feed to animals** **2= Put on compost heap** **3= Sold** **4= Bartered** **4= Other (specify)**
Units of green cobs **1= Cobs** **2= 50 kg sack** **3= 3 ton pick up** **5= 5 ton pick up** **6= Other (specify)**	Harvest **1= Remove ears** **2= Cut stalk and ear** **3= Other, specify**	Units of dry cobs **1= 90 kg sack** **2= 3-ton pick up** **3= 5-ton pick up** **4= Debe** **5= Kasuku tins** **6= Other (specify)**	

VISIT 1: If manure was used on the maize patches

From which animal did the faeces come	
Were faeces mixed with bedding	
Were faeces mixed feed refusal	
Were faeces mixed with other material	
If yes what	
How long was the manure stored before use	

****manure may be from more than one source, so may need more than one copy of this table**

VISIT 2:
Were any maize patches (not just those in survey) left unweeded at the time when 1st weeding would normally be carried out and if so why.

VISIT 4:
Of all the maize you produced on your farm, what was the total harvest and how much was sold/consumed at home?

	Green maize		**Dry maize**	
	Units & kg equivalent	**No. of units**	**Units**	**No. of units**
Total produced				
Total sold				
Total consumed at home				
Total given away				

For maize that you sold what was the selling price

Item	**Unit**	**** Kg per unit**	**Price per unit**	**No. of units sold**
Dry maize				
Dry maize				
Dry maize				
Green maize				
Green maize				
Green maize				

Crop Protection

Longitudinal survey

Forage offered information – to be completed at each of 4 visits

Farm reference number

1. **Name of Household head**
2. **Name of Respondent**
3. **Name of Enumerator Administering Survey**

WEEDS AS FORAGE	**Were weeds fed? Y/N**	**Give names of *flowering weeds fed to livestock***
Visit 1: 1st weeding		
Visit 2: 2nd weeding		
Visit 3: Late tasselling		
Visit 4: Dry harvest		

What forages have you fed to your animals since the last visit and where did they come from (in the last month at visit 1) Table overleaf

Were any maize forages affected by diseases other than MSV Y/N

If so which forages?

Which disease(s)?

Any other comments/observations

Inventory of forage use including quantity, costs and quality

						MSV infected MAIZE forages		
Visit No.	**Type of forage (Code)**	**Source of forage (Code)**	**Unit**	**No. of units**	**Purchase: Cost / unit or bartered**	**% of forage affected by MSV**	**If less what would you pay**	**If more what would you pay**
1= 1st weeding **2= 2nd weeding** **3= late tassel** **4= dry harvest** **9= other**	**1=own farm** **2= gathered off-farm** **3= purchased** **4= bartered** **9=other**			**CODE FOR UNITS**	**In KShs or for what if bartered**	**Enter 0 if not affected**		

Codes for forages:	**5 Weeds**	**10 Baled straw**	**15 Kale residue**
1 Maize thinnings	**6 Napier grass**	**11 Grazed pasture**	**16 Forage legumes**
2 Green maize stover	**7 Sudan grass**	**12 Banana pseudostem**	**17 Tree forage**
3 Dry maize stover	**8 Grass hay**	**13 Banana leaves**	**18 = Other, specify……**
4 Bean residue	**9 Roadside grass**	**14 Sweet potato vines**	**19 = Other , specify……...**
			20 = Other, specify……