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

Results of a rapid rural appraisal held in April and May 2001

Anni McLeod[1], Jackson Njuguna[2], Francis Musembi[2], Jedidah Maina[2], David Miano Mwangi[2], Dannie Romney[3], Alistair Murdoch[4]

1. PAN Livestock Services Ltd, Reading, UK.   2. Kenya Agricultural Research Institute
3. International Livestock Research Institute, Nairobi, Kenya
4. The University of Reading, Department of Agriculture, U.K.

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Enquiries in the UK to: Dr Alistair Murdoch, Department of Agriculture, The University of Reading, Earley Gate, PO Box 237, READING RG6 6AR, UK.

Enquiries in Kenya to: Dr Jackson Njuguna, Kenya Agricultural Research Institute, National Agricultural Research Centre – Muguga, PO Box 30148, Nairobi, Kenya.

Or Dr David Miano Mwangi, Kenya Agricultural Research Institute, P.O. Box 57811-00200, Nairobi. Kenya. Telephone +254 (0)20 583301-20 ext 2316
Email: a.j.murdoch@rdg.ac.uk or dmmwangi@kari.org or jack.kari@africaonline.co.ke

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Executive summary

1. The study described in this report was the first activity of a project to improve the quality of forage provided to smallholder dairy cows through the control of foliar diseases and weeds of maize. It was carried out in ten communities of Kiambu district, in the Central Highlands of Kenya. As well as adding to existing knowledge of maize management and dairy cow feeding practices, the study aimed to assess current control strategies for weeds, pests and diseases of maize and the farmer perceived impact of maize diseases and weeds on forage yield, quality and seasonal availability. The results of the study have contributed to design of an on-farm longitudinal study and on-station experiments in control of *maize streak virus* disease.

2. As previously suspected, forage was found to be 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.

3. *Maize streak virus* disease is perceived 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. A strategy for early control taking account of the epidemiology of the disease is essential.

4. Farmers are, however, generally unaware of the epidemiology of the disease and do not know how to control it. The wide range of planting dates and relay cropping may be encouraging disease spread. Resistant cultivars are not generally available in Kenya.

5. The second most important pest/disease of field crops was maize stem borer but control was not perceived to be a problem. Farmers may have confused leaf blight with frost damage.

6. 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 contribute a large volume of forage.

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

Background

This report describes the first study made in a research project investigating the interactions between pests, weeds and foliar diseases of maize, in particular *maize streak virus* disease, and feeding of smallholder dairy cattle in the Central Highlands of Kenya.

The project is sited in Kiambu district, in the heart of the Central Highlands. Much of the district falls within the Nairobi milkshed 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. Com.). MSVD appears to be the most common and potentially damaging of the diseases in Kiambu District. 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. Little is known about effective ways to control it. Weeds infesting maize crops and non-cropped vegetation in adjacent land are potential sources of inoculum (Onudi , 1995). In addition, weeds directly reduce yields in maize. 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).

The project intends to investigate strategies for control of MSVD that are appropriate for use by farmers in the Central Highlands. It is also open to the possibility of researching control of other foliar diseases, if they prove to be important and where this does not clash with existing research in Kenya.

The first stage of the project, described in this report, was a rapid appraisal. It aimed to:

1) add to existing knowledge of maize management;

2) add to existing knowledge of dairy cow feeding practices;

3) assess current control strategies (for weeds, pests and diseases of maize);

4) assess the (farmer) perceived impact of maize diseases and weeds on forage yield, quality and seasonal availability;

5) contribute to the design of a longitudinal study that will be carried out on-farm over a period of at least 12 months to investigate the impacts of foliar diseases and weeding regimes on forage yield, quality and seasonal availability in more depth.

Given the work that has already been done on both maize and dairy cattle in the project area, the team felt that the most useful addition to knowledge would come from the interaction between the maize crop and the dairy system, in particular the times of year when weeds, thinning and stover were most important and whether weed, pest and diseases control practices appeared to be affected by considerations about the availability of forage. Previous and ongoing studies have focussed on either one of the systems, not both at the same time. For example, ongoing work on weed control, including some detailed labour assessments, has chosen to regard the weed as a problem rather than a potential resource and has assigned no value to it (Maina, Musembi, pers. comm; Projects R7402 and R7404). The activities carried out during the RRA were expected to demonstrate the contribution of maize to forage and the potential constraints to forage imposed by pests and diseases, in particular MSV as well as providing background information needed for design of on-station trials which will form the next stage of the project.

Methods

Study team

The study was conducted by a multi-disciplinary research team from the Kenya Agricultural Research Institute (KARI), with assistance in study design, piloting and analysis by a socio-economist from PAN Livestock Services Ltd. The Kenyan team comprised a crop protectionist, a weed scientist, a livestock nutritionist and a socio-economist. Early inputs to the study design were also made by a crop protection and livestock production team from The University of Reading and a livestock nutritionist from ILRI. Members of the extension services facilitated introduction to farmers and accompanied the research team on field visits.

Study site

The appraisal was carried out in Kiambu district during April and May 2001. Rainfall in the district is bimodal and the long rains normally begin at the end of April or beginning of May. The study comprised two interviews with each of ten farmer focus groups. Groups consisted either of existing formal or informal groups within the study communities, or farmers from the community who were interested in attending the meetings. The sample of villages was chosen purposively to represent areas of high and low MSVD incidence, different production systems, and differences in resource endowment. Production systems were coffee-dairy, maize-dairy, vegetable-dairy and tea-dairy. Maize was grown in all systems. Within Kenya a number of these agro-ecozones have been identified (initially by Jaetzhold and Schmidt, 1983), where most smallholder farms in an area will include enterprises dictated by rainfall, temperature and in some cases influence of a major producer providing a market, such as a large tea estate. Lower resource endowment was represented by a drought prone area with limited access to the Nairobi milk market (Thigio), a village where many small farmers were known to rent land from larger farms (Kawainda), and a village where plot sizes were very small and some farmers were squatters (Kiambaa). Table 1 shows the list of villages chosen.

Table 1. Study villages for the RRA

Division	Village	Code	MSV incidence	Production Zone	
Githunguri	Gitwe	1	H	Tea-dairy	tea keeps farmers very busy, limited extension attention
Githunguri	Kiaria	2	H	Coffee-dairy	
Kiambaa	Kawainda	3	H	Coffee-dairy	have own small plots, lease land from large farms for growing maize, some women in village are landless but did not come to meeting
Ndeiya	Thigio	4	L	Maize-dairy	drought-prone area, should be lower market access
Kikuyu	Kanyiriri	5	H	Maize-dairy	maize-dairy zone but many farmers have plots too small for cattle
Lari	Kamburu	6	H	Tea-dairy	
Lari	Kinale	7	L	Horticulture-dairy	
Limuru	Ngecha	8	H	Coffee-dairy	small scale farms surrounded by tea estates
Limuru	Kinyogori	9	L	Horticulture-dairy	cool, wet zone with small farms surrounded by large tea estates
Kikuyu	Kiambaa	10	H	Coffee-dairy	very small land holdings, some farmers are squatters, the only study village with true landless

Groups consisted of between 8 and 38 people, both men and women, as shown in Table 2. It had originally been proposed to interview men and women separately, but in the pilot study, when mixed groups were interviewed, both women and men contributed readily where they

had knowledge. Women were more vocal when discussing weeds and men when discussing cattle and forages but both had something to say on each subject. Previous experience of the team suggested that women may be unwilling to contribute to group discussions if their husbands are part of the group but are not intimidated by the presence of other men. Therefore, the team decided not to segregate the groups. In some villages an organised women's group formed the core of the focus group, but in most cases the group was mixed-gender.

Table 2. Group size

Division	Village	Code	# people	men/women
Githunguri	Gitwe	1	11	2/9
Githunguri	Kiaria	2	38	32/6
Kiambaa	Kawainda	3	21 & 10	mostly women
Ndeiya	Thigio	4	19	11/7
Kikuyu	Kanyiriri	5	8	0/8
Lari	Kamburu	6	18	9/9
Lari	Kinale	7	18	18/0
Limuru	Ngecha	8	20	11/9
Limuru	Kinyogori	9	14	9/5
Kikuyu	Kiambaa	10	9	1/8

Activities

With each group the following activities were run:

- a seasonal calendar for the maize crop

- a seasonal calendar for forages fed to livestock, with scoring of each forage in each month

- a matrix of weeds found in the maize crop, with scoring for their impact on yield, difficulty and expense of control

- a matrix of pests and diseases found in the maize crop, with scoring for their impact on yield, difficulty and expense of control.

- a crop-stage calendar for MSV showing stages of the crop when it appeared and its relative impact at each stage. If MSV was scored as unimportant or another foliar disease scored very highly, there was the option to do a crop-stage calendar for an additional foliar disease, but this occasion never arose.

Details of information sought from each activity are shown in Appendix 1.

Since the total time needed for the activities was 5-6 hours, two visits were made to each group. Many people in the groups were literate, so records were made on manila paper taped to a wall. A member of the group assisted with recording. After the first visit, the records were usually left with the group to keep safe until the next visit. After the second visit the records were left with the group if they wished to keep them and copies were made by the field team.

A team of three of the total four researchers in the study team made each visit - one facilitator and two note-takers. The team carried colour pictures or examples of the most common weeds and diseases so that even if the names were not known and the facilitator was inexperienced in that area, identification could be made later, The interview location was chosen by the farmers. Interviews were conducted in the local language (Kikuyu) and records made in the same language, but notes taken in English.

Data analysis

The reports for each group were sent to Reading by email for analysis, which was done in Microsoft Excel™. They consisted mostly of graphical presentation, summation and averages. Where additional analysis was done this is noted in the results. Analysis was completed when the Kenyan team had commented on the presentation of the findings.

Results

Maize crop calendars

Figure 2 (overleaf) shows the maize crop calendars indicating the timing of each major activity. Villages are grouped by production zone. Production zones relate to climate and topography and might be expected to dictate the timing pattern for maize activities in terms of climate and labour availability. However, no very clear picture emerges except for a bimodal cropping pattern in nine of the 10 villages. Differences in timing of activities might reflect local variations in rainfall or differences in reporting, since the rainfall pattern in Kenya has been quite variable in the last few years, affected by El Nino.

The most common pattern was two crops a year timed for the rains (long rain in approximately April-June and short rain in October). In villages 1 and 6 there was sufficient moisture to plant at any time of year and an in-between crop might be planted purely for forage purposes. Village 4, in a drought-prone area, could only reliably expect to plant one crop a year.

Popular varieties are shown in Figure 1. H614 was grown by 8 of the 10 study groups. Other popular varieties included H625, H626, H627, H513 and H511. The 6 series were preferred as they gave high yields of both grain and stover, but needed more rain and tended to be grown in the long rains season. The 5 series and the local Kikuyu variety, however, matured more quickly, required less rain and tended to be grown in the short rains. In village 9, local varieties were used when farmers had insufficient cash to buy certified seed. There was little knowledge of streak resistant varieties.

Figure 1. Number of farmer groups reporting use of different maize varieties.
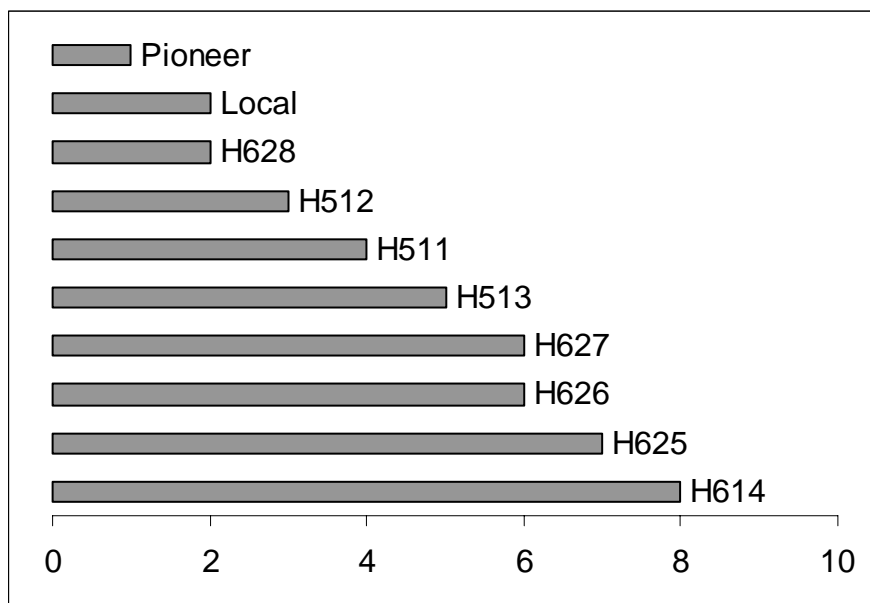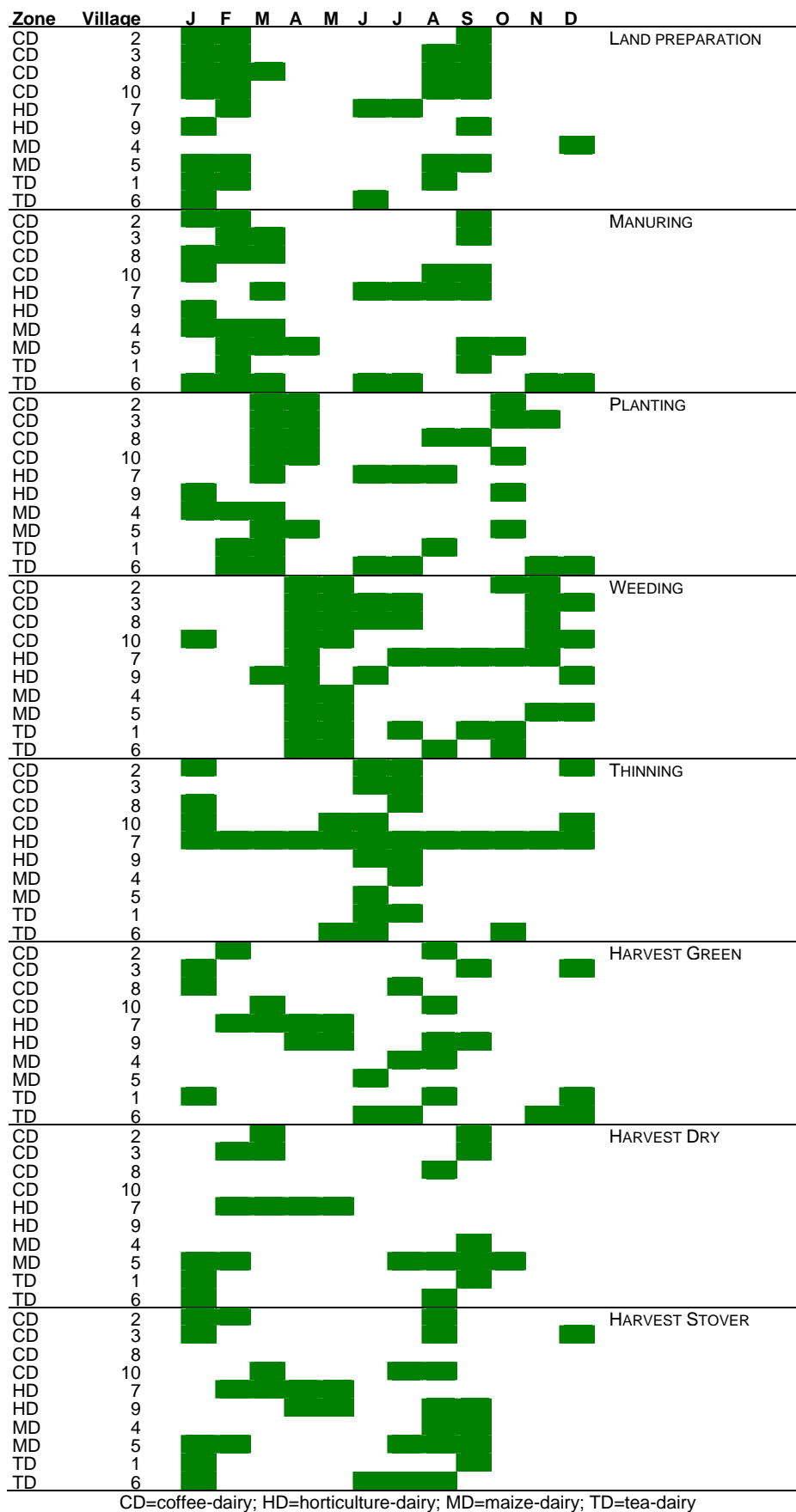
Figure 2. Maize cropping calendar

CD=coffee-dairy; HD=horticulture-dairy; MD=maize-dairy; TD=tea-dairy

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Manure was widely used when it was available. In village 5, where plot sizes were in many cases too small for cattle, farmers without cattle traded stover for manure. In village 8, where vegetables were an important source of income, farmers would buy manure for vegetable growing. In village 10 most farmers used fertiliser and not manure. Fertiliser was also applied into the planting hole (types shown in Figure 3). DAP and 20:20:0 were widely available in local markets. 25:5:5+SS was used in village 1 because it could be obtained on credit from tea estates, although it is really a tea fertiliser. CAN was used for top dressing. A few farmers in 6 out of the 10 groups interviewed used "Marshal" (active ingredient Carbosulfan) seed dressing against MSV. The dressing is available from extension staff. Some farmers said it was expensive, but at present it is distributed free in demonstration-sized packs.

Figure 3.Number of groups using different fertilisers.
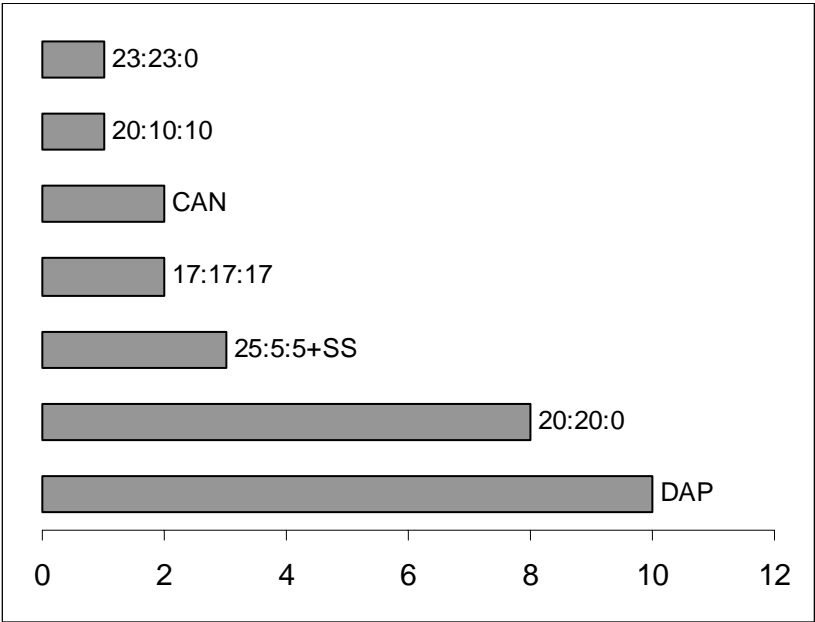
Planting densities ranged from 2.5x1 to 3x1 and from 2 to 4 seeds per hole, later thinned to 1-2 plants per hill. The density and seed numbers were intended to provide thinnings for cattle. One group (village 9) would plant at 2x1 feet for forage and 3x1 feet for human food. Weaker plants were generally thinnings for cattle feed. Several groups said that they did not feed smutted parts, or removed the smutted part. Streak was not mentioned as preventing farmers from feeding thinnings or stover, although it reduced the yield and quality.

Depending on the village, weeding was done by women, women and children, the whole family, or with assistance from hired labour. However, women were generally acknowledged as being the main players and the most knowledgeable about weeds. Generally, a first weeding was carried out as soon as weeds showed competition to the emerging crop. The weeds from this were small and not fed to livestock, and might be left in the field once uprooted. A second weeding was carried out, usually about a month later, to provide larger weeds for livestock feeding.

The majority of the crop was harvested dry. Some was harvested green as green harvest provides higher prices for cobs and higher milk yield from cattle fed green stover. Green cobs and stover might be sold, dry harvest, especially smaller cobs, was consumed at home. In village 5, where holdings were very small, farmers rarely had enough yield to harvest green and sell. In village 10, where holdings were also small, they chose to harvest green and rarely harvested dry.

Forage calendars

Figure 4 shows the annual importance of different forages, obtained by adding all of the monthly scores allocated by all of the villages and representing each score as a percentage of the total of all scores. Napier scored very highly, with 41% of the total, followed by grass (15%), green stover (10%) and thinnings (8%). Crop sources (thinnings, stover and weeds from the crop) made up 29% of the annual total score, showing that they are an important forage source. Weeds from outside of the crop were of negligible importance (1%). "Other" forages varied with village and included cotton husks (village 8), poultry waste (villages 5 and 10), oats (village 7), kale (villages 7 and 9), pears and reeds (village 9).

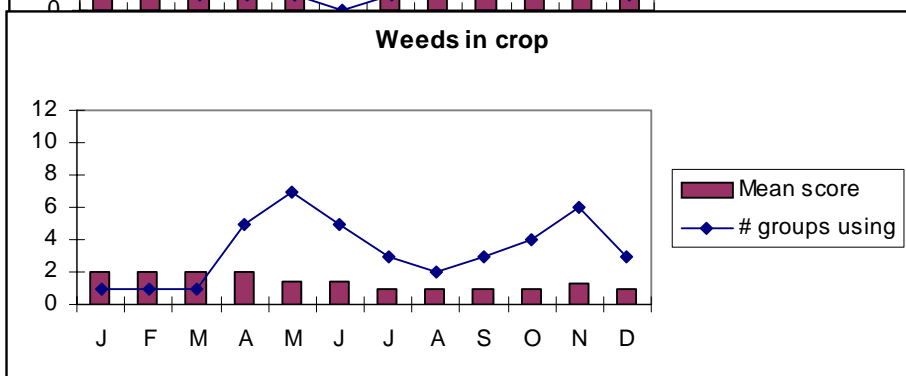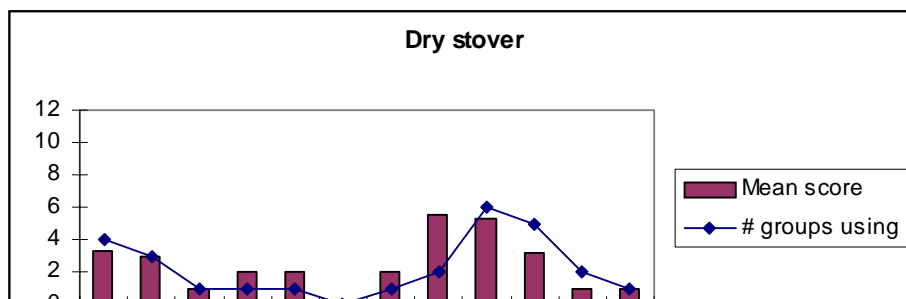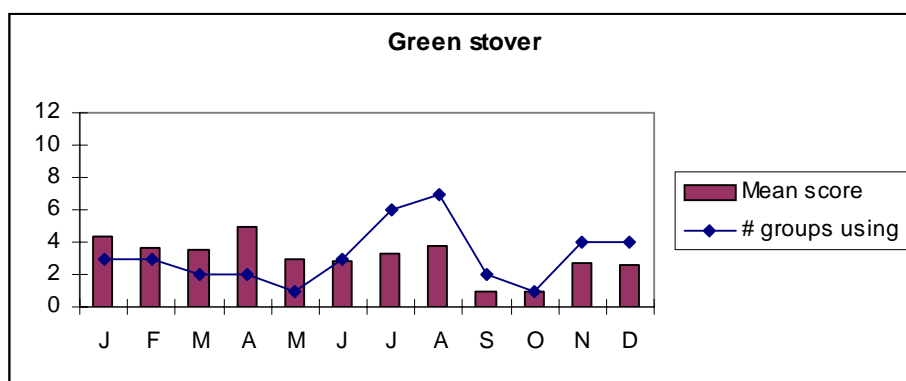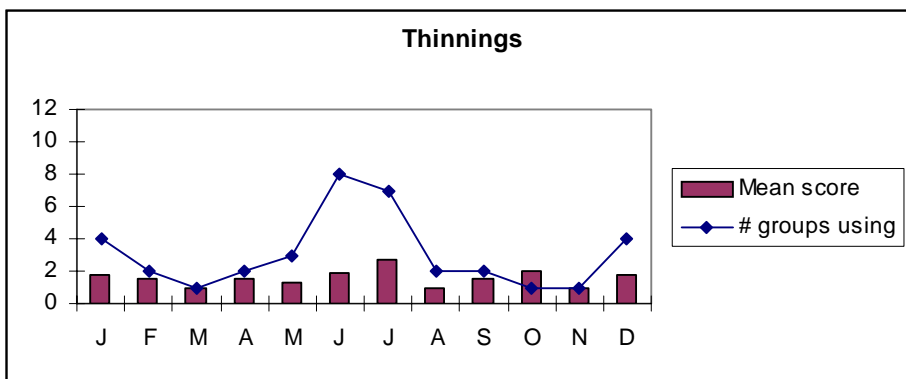**Figure 4. Total annual usage score for forages highlighting those from maize crop**
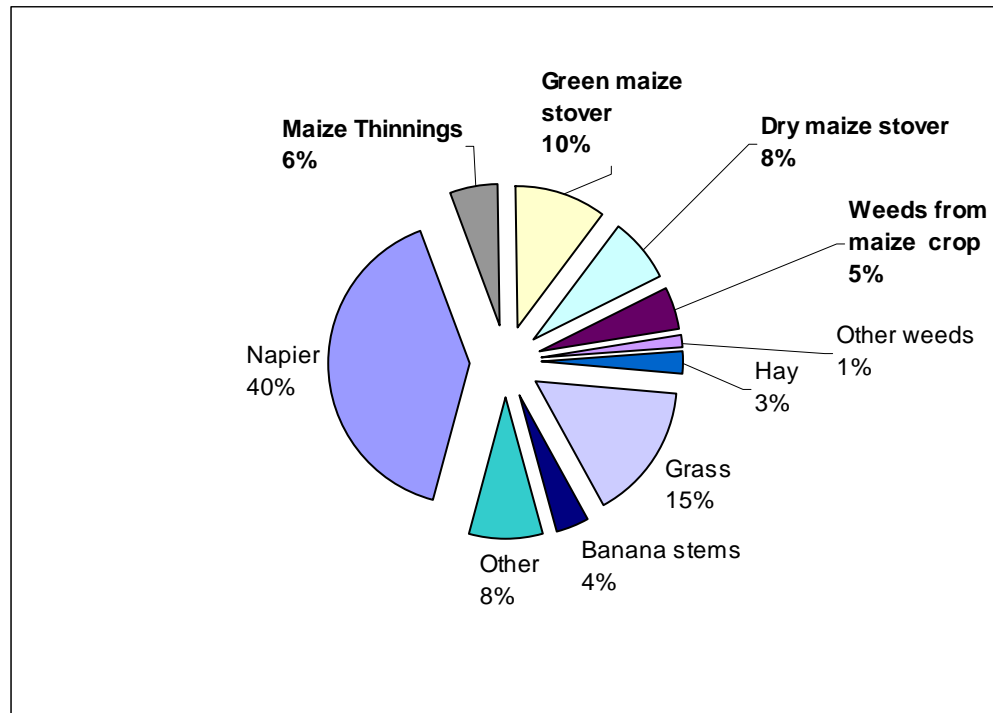
Equally important are the seasonal contributions of different forages. Figure 5 shows the number of villages using forages in each month and the mean importance score out of four.
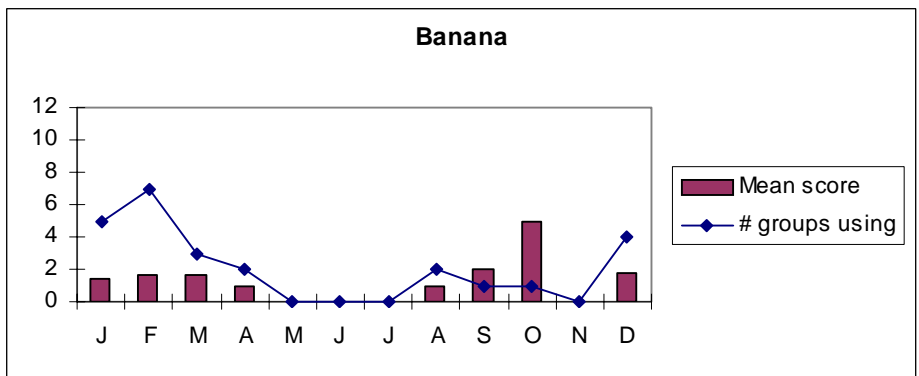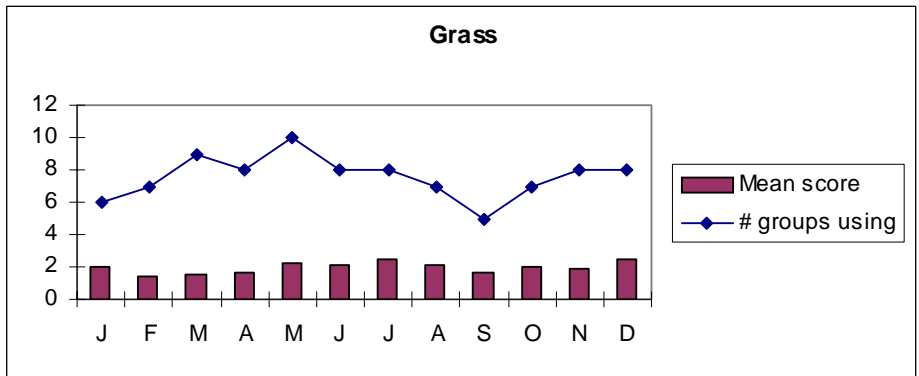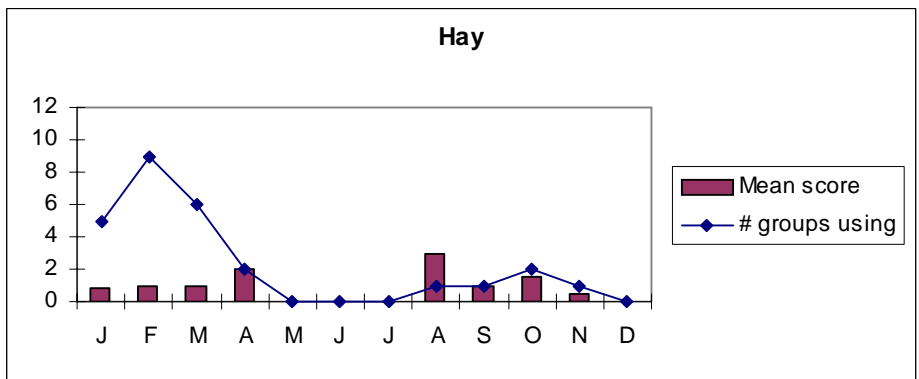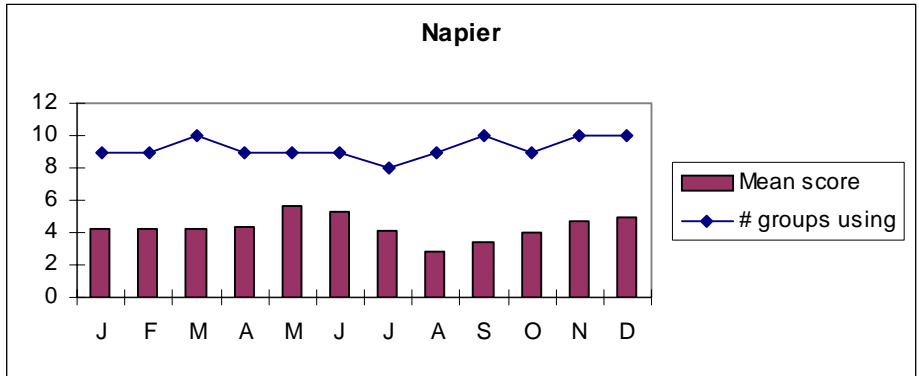
The crop sources were used as they became available. Weeds from the crop were most widely used in April-July and November, during the second weeding, but never scored very highly because the quantity is small. As thinnings and stover became available, particularly between June and October, they became an important contributor, and dry stover again became important in the forage-scarce months of January and February. Green stover had a consistently high score except in September and October. It was considered to be good for milk yield. In some cases dry stover was stooked and preserved for months of scarcity.

Of the non crop sources, Napier was used consistently throughout the year, with 8-10 groups reporting its use each month. It was least important in village 7 and showed a very strong seasonal variability in village 6. Grass was also consistently important although not used regularly by as many groups. Sudan grass and Kikuyu grass were among those mentioned.

The first quarter of the year was universally a period of forage scarcity (Figure 6). Farmers would feed any forage they could find, and if necessary buy hay or concentrates, buy Napier from farmers with no livestock (village 4) or gather weeds from off the farm (village 6). The groups had difficulty scoring forages for this period because availability is so varied and so many forage sources may be used.

Figure 5. Number of groups reporting use of each forage and mean score out of 4 for importance in each month

Thinnings

Green stover

Dry stover

Weeds in crop

Napier

Hay

Grass

Banana

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These general observations relate to the overall effect, but cropping patterns in individual villages, and hence the month-by-month importance of different forage, vary slightly by location and year.

Figure 6. Seasonal forage scarcity

| Village Zone	J	F	M	A	M	J	J	A	S	O	N	D
2 CD		■	■	■								
3 CD	■	■	■									
8 CD												
10 CD	■	■	■									
7 HD												
9 HD			■							■	■	
4 MD	■	■	■									■
5 MD	■	■	■									
1 T												
6 T		■	■									

Weeds

A very long list of weeds was reported by the groups to be found in maize crops, including some with local names that could not be identified. A complete list is given in Appendix 2. Weeds that were reported by at least three groups are shown in Figure 8. The listing of weeds in this and subsequent figures is arranged in order of their perceived impact on stover yield, shown in Figure 10. *Commelina* species and *Bidens pilosa* were reported by all ten groups to be found in the long rains maize crop. Other very common weeds were *Gallinsoga parvi* (gallant soldier), *Digitaria abyssinica* (couch grass), *Tagetes minuta* (Mexican marigold), *Cyperus spp* (nut grass) and *Oxalis spp.* Most weeds could be fed to livestock, except for Datura (not in the figure) which was poisonous.

Figure 8. Frequency of reporting of weeds in maize (no. villages)
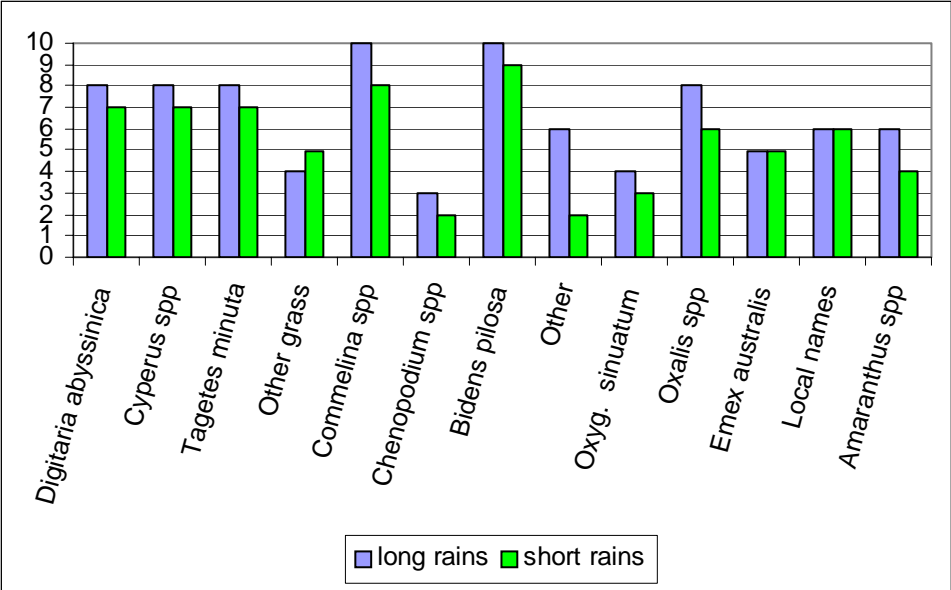
Weeds were mostly removed by hand hoeing. Women were the most important players, but in some villages men, children and hired labour would also contribute. The first weeding was done when weeds were small, to prevent competition with the crop. About a month later a second weeding would be carried out, removing larger weed plants to feed to cattle. Four villages used herbicide to control couch (villages 3, 4, 5 and 6) but herbicides were not used on other weeds.

Figure 9 shows impact on grain yield. *Cyperus* and couch were universally considered to severely reduce yield. Grasses and the locally named weeds were more variable but considered very important by some groups. Figure 10 shows the scores for perceived reduction of stover yield. Scores were universally slightly lower than for grain yield, but again *Cyperus* and couch were considered the most important.

Figure 9. Farmer perceptions of the impact of weeds on maize grain yield (scores / 5)
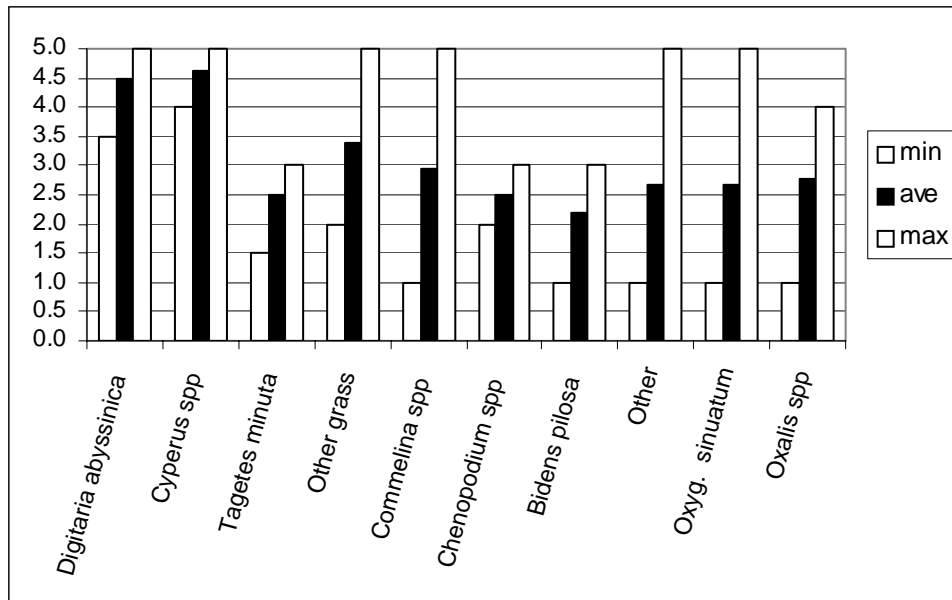
Figure 10. Farmer perceptions of the impact of weeds on maize stover yield (scores / 5)
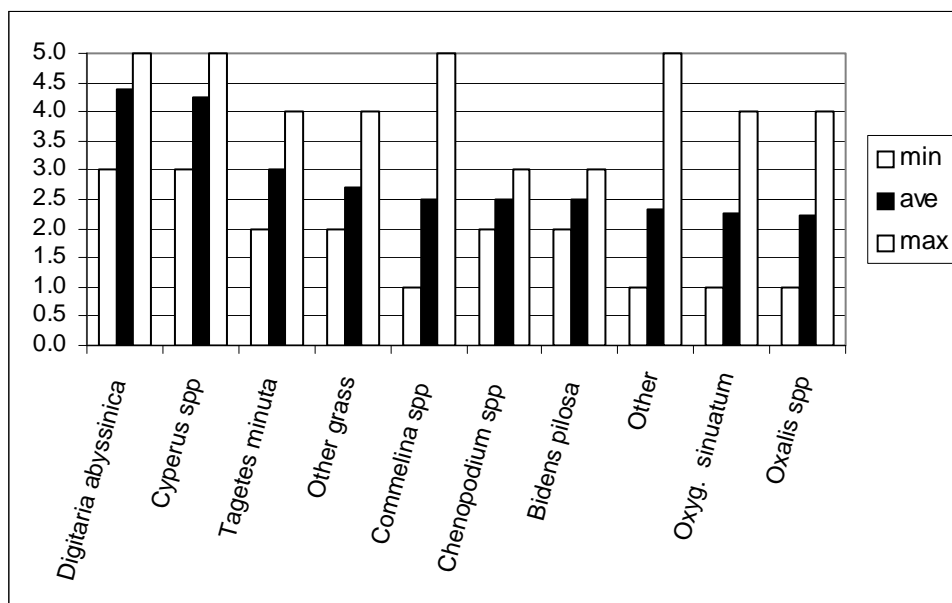
Scores for difficulty of controlling weeds are shown in figure 11. Difficulty related to growth habit (e.g. couch and *Cyperus*) making weeds hard to remove completely so that they would re-grow, and thorns (*Emex australis,* commonly known as Devils thorn) which made weeding an uncomfortable process. Since herbicide was mainly applied to couch, a great deal of labour was involved in removing persistent weeds. The team did not determine whether non-use of herbicide was a choice because weeds were needed for animal feed, or a result of tradition or lack of cash. This is something that could be explored further in the longitudinal study.

Scores for expense of control are shown in Figure 12. Expense included herbicide and labour (this was meant to be hired labour, carrying a cash cost, but may have included some family labour). Four villages reported using a "very expensive" herbicide against couch, one used herbicide against cyperus. Weeds which were difficult to control also needed a lot of "expensive" labour although it was not clear whether this related to the time required or whether differential rates were charged.

**Figure 11. Farmer scores for the difficulty of controlling weeds (scores / 5)**
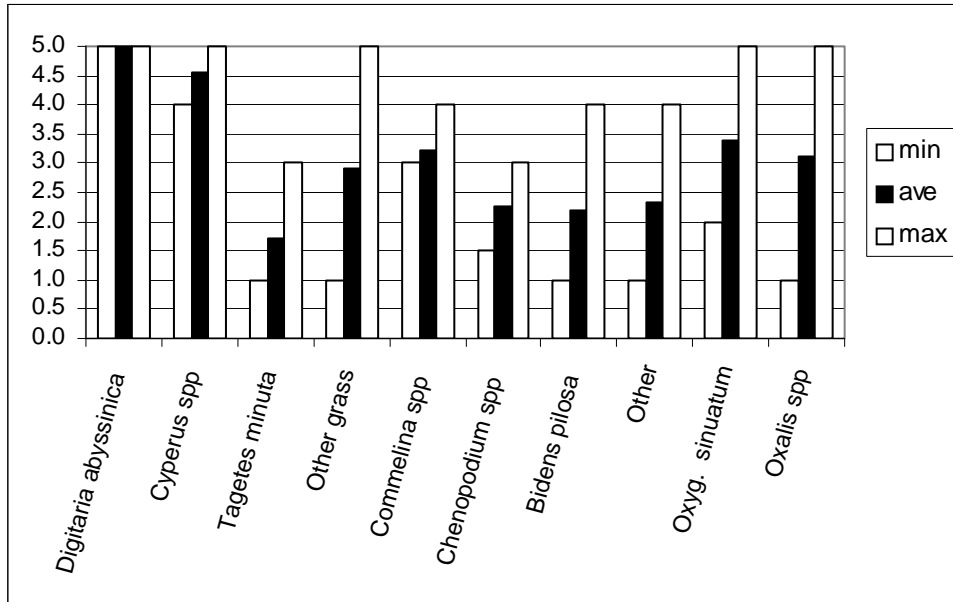
Figure 12. Farmer scores for the expense of controlling weeds (scores / 5)
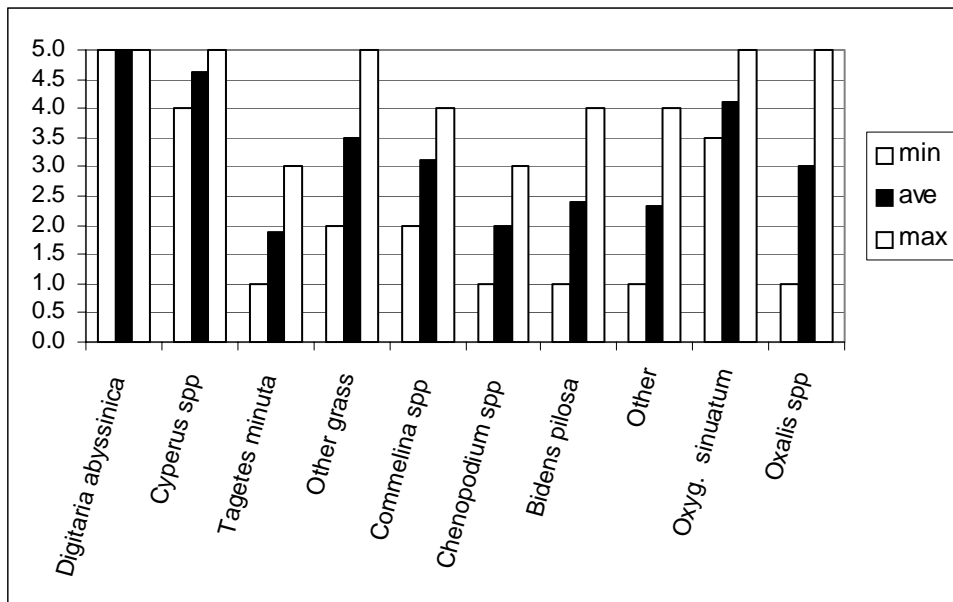
Pests and diseases

The pests and diseases most commonly reported in maize are shown in figure 13. The order in which pests and disease are listed in this and subsequent figures relates to their perceived importance in reducing stover yield, shown in Figure 15. MSV, Smuts (in the head), Stem borer and cutworm were reported by almost every village. The "other" category includes crickets (village 5), a butterfly (village 4), squirrels (village 8) and a condition called "dwarf" (village 10). Locally named diseases that could not be identified were "Njururi" (village 4) and "Kaganyu" (village 6). Apart from MSV no foliar disease was widely reported. Of villages in the low incidence zone, village 4 had only one crop, in which MSV was seen, village 9 saw it only in the long rains crop and village 7 in both crops. All villages in the high incidence area saw MSV in both crops except village 5, which only saw it in the short rain crop.

Figure 13. Frequency of reporting of pests and diseases (no. villages)
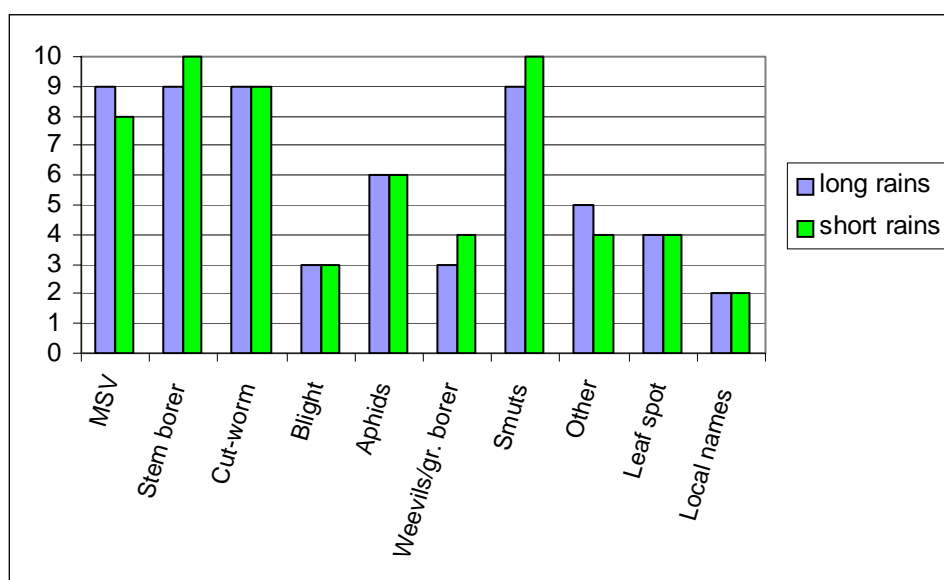
Figures 14 and 15 show the perceived impact of different pests and diseases on grain and stover yield. MSV scored most highly on both counts. No other foliar disease had a high mean score for grain or stover impact. The average score for stover impact was slightly higher in the villages with expected high incidence, while for grain it was slightly lower. Village 7 reported low scores for both. However, it would not be wise to read too much into this as higher and lower scores were found in both groups . Smut and weevils/grain borers were perceived to have a high impact on grain yield. Smut prevented plants or parts of plants being fed to cattle. MSV did not prevent thinnings or stover being fed to cattle although it reduced both quantity and quality. One village reported that cattle rejected stover with aphids.

Figure 14.

Farmer perception of the impact of pests & diseases on grain yield (scores / 5)
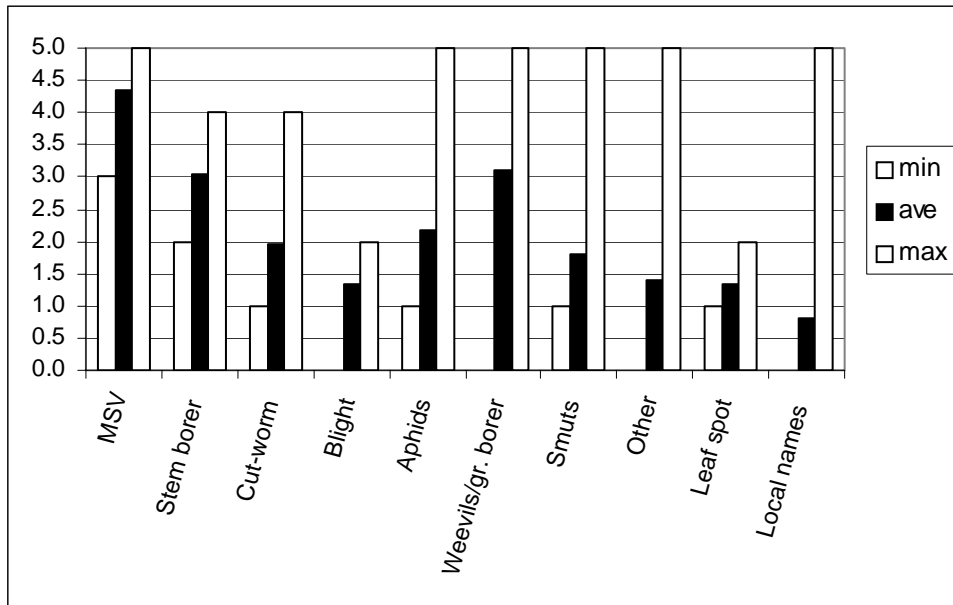
Figure 15.

Farmer perceptions of the impact of pests & diseases on stover yield (scores / 5)
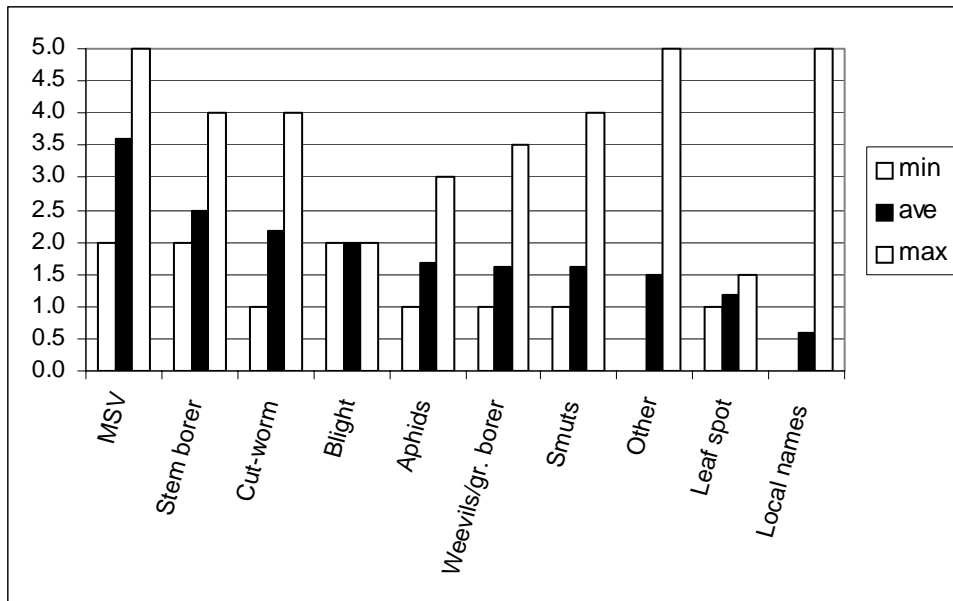
Figure 16 shows the reported difficulty of controlling different pests and diseases. Those that were reported as difficult to control tended to be those for which farmers did not know a control method. MSV scored very highly with 9/10 groups. The mean score for the expected high incidence area was slightly higher (5 against 4). Village 7 was more concerned with frost. Apart from a dressing called "Marshal", available from extension staff and used by a few farmers, no chemical control method for MSV was known. Farmers would remove young diseased plants and re-seed but the disease tended to spread over a large area. Squirrels, crickets and butterflies also scored highly but were only reported in one village each. Smut was reported by one group as spreading over the whole field while another said it was easily to control by removing diseased plants. Control expense (Figure 17) was generally low because chemicals

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were not much used. For MSV the mean score was higher in the expected high incidence villages (3.4 against 2.3).The cost of seed and labour of replanting were mentioned for pests and diseases that destroyed young plants (such as MSV and cut-worm) but did not appear to affect the control cost score. In asking about expense the team focussed on cash cost, and replanting would probably be done by family labour.

Figure 16. Farmer scores for the difficulty of controlling pests & diseases (scores / 5)
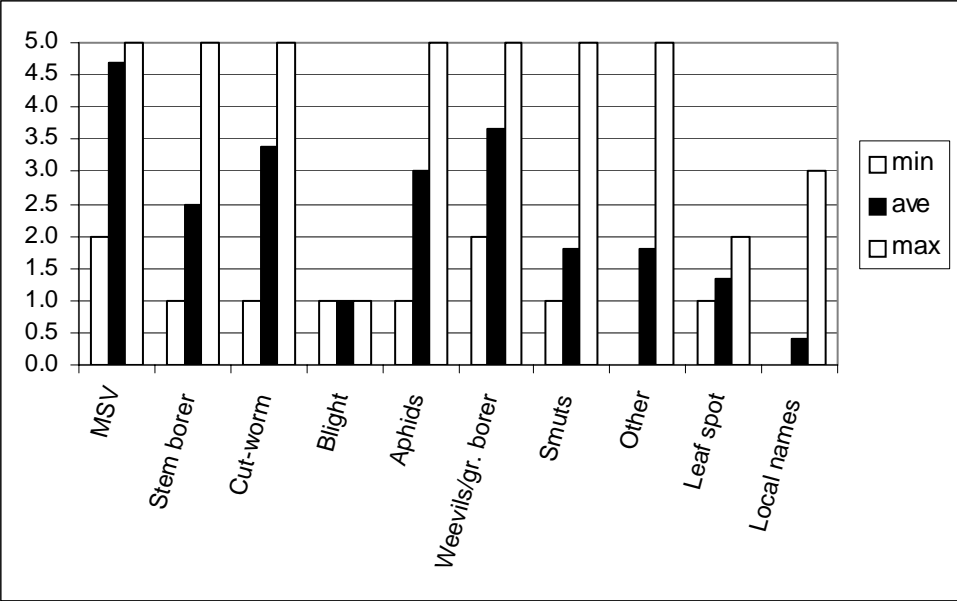
Figure 17. Farmer scores for the expense of controlling pests & diseases (scores / 5)
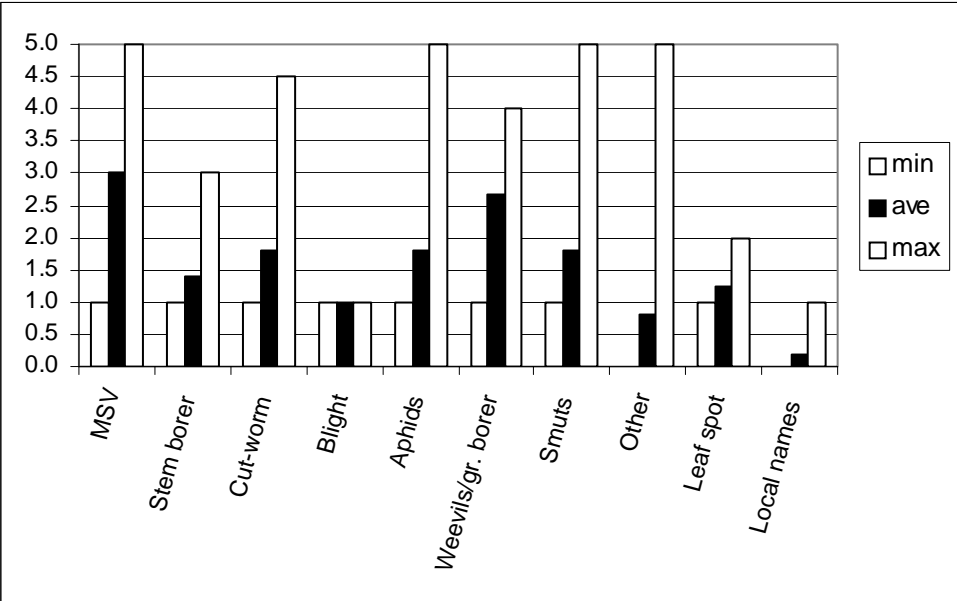
Since MSV was the only foliar disease reported frequently or scoring highly, it was the only one for which a more detailed calendar was made. This is shown in Figure 18. The scores shown are totals for scores out of 5 for frequency of appearance at different crop stages. The highest score (and therefore the most frequent first appearance) was before flowering, which was reported by all 10 groups. Eight groups reported disease appearance before knee height and the total score for this was also high. First appearance at later crop stages was rarer. No group had any knowledge of it on other crops or plants. When it appeared before knee height, the impact on grain and stover yield (Figure 19) was devastating, because the plant went entirely yellow and did not grow. Appearance from knee height until before flowering also

caused grain and stover loss, although it was not as severe. Appearance at later stages had a much smaller impact.

Figure 18. Total scores for the frequency of MSV at different crop stages
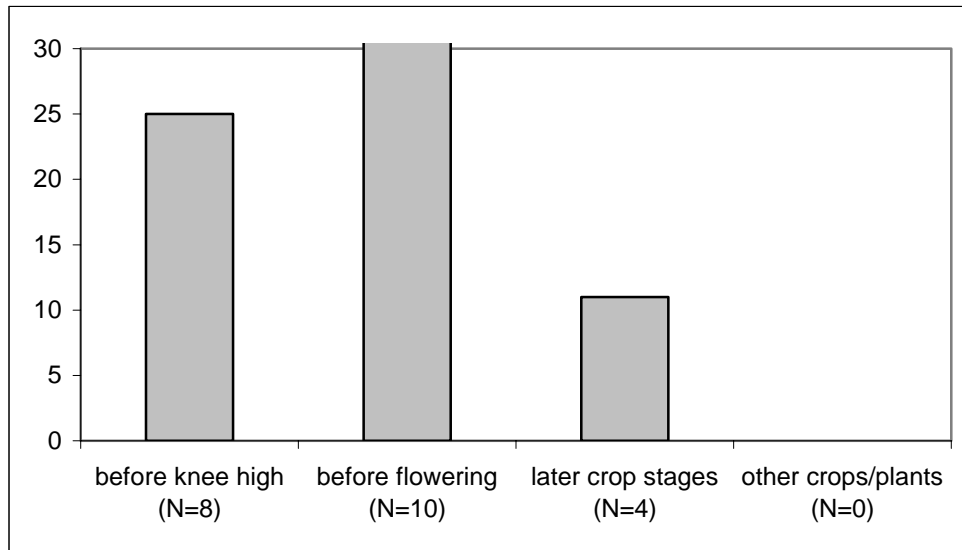
Figure 19. Mean scores for MSV impact on grain and stover at different stages

Conclusions

1. The study confirmed that MSVD appears to be an important disease in Kiambu District, affecting both grain and stover yields as well as stover quality. This has implications for food security and income. It was by far the most highly scored of all foliar diseases. It does seem that less "visible" foliar diseases are less well known than perhaps they deserve; but this does not reduce the importance of MSV.

2. No information was obtained on seasonality of the MSV leafhopper vector and farmers seemed to have little understanding of the epidemiology of the disease.
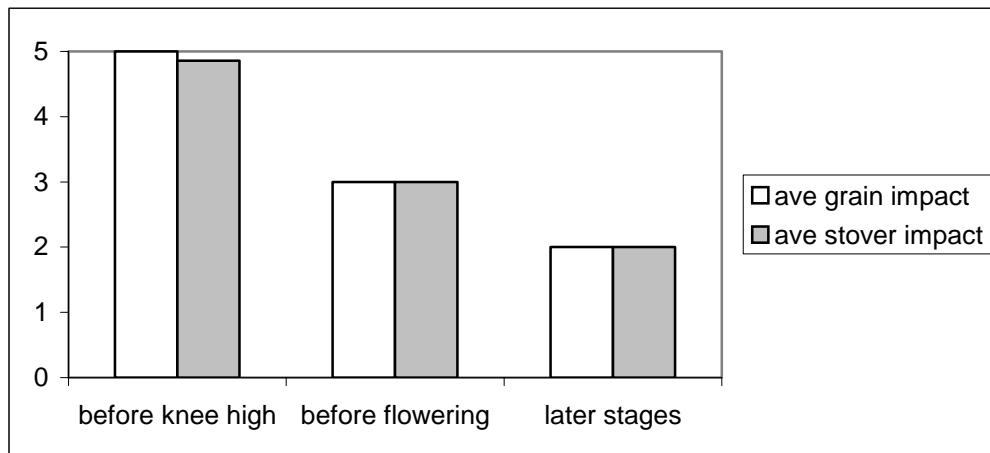
3. Of other pests and diseases occurring in the field, maize stem borer ranked second to MSVD in its effect on both maize grain and stover yields. It is not completely clear whether leaf spot and blight have a low incidence in the study villages, or whether they occur but are not noticed by farmers.

4. It is interesting to note that head smut was mentioned by all groups, although it is easily controlled by systemic fungicide. Farmers did not spend much on chemicals for their maize and may have preferred rogueing as a control method, but this was not investigated by the study.

5. Napier was the most widely used forage and the most important in terms of quantity fed.

6. Forages provided from the maize crop were, however, seasonally important and both the planting and harvesting strategies of maize reflect the value placed on thinnings and stover. The preservation of high quality stover for the scarce months (three months between October and March, varying with location) would be valuable both for security of mind and in saving money (hay, bran and other forages are purchased when forage is scarce). It is less clear what importance weeds have in the feeding strategy since their total score as a source of forage was not very high. However, the weeding regime appeared to be arranged to provide large-sized weeds from the second weeding for cattle feed. At present very little herbicide is used, but other research is finding considerable interest in herbicide use. It would be valuable to assess the true value of weeds for use in economic assessment of herbicide potential.

7. When seen at an early stage of the crop, which is quite common, MSVD can cause total loss of the young crop, which then needs to be replanted, with cost and lower yield, or may be completely lost for a season. Since crops are planted close together and may overlap chronologically in wetter areas, it is easy for the disease to spread from a mature crop to a new one. Disease later in the crop has a much smaller effect. A control strategy reducing incidence of MSVD up to knee height would be especially valuable.

8. MSVD preoccupied farmers because they do not know of a reliable control method. The possibility of resistant varieties had not been explored by them or the extension staff. Choice of variety is in any case strongly influenced by what is familiar and available. Any resistant variety for use in the long rains crop would need to have high grain and stover yield since this was mentioned as important by all groups. A resistant crop for short rains use would need to be fast maturing.

9. At certain times of year there is a heavy labour burden on women. Labour appears particularly short at weeding time and it is therefore obvious why herbicides would be tempting. Therefore, a labour-intensive regime for MSVD control may not be popular. Equally, a regime that imposes strict rules on timing of forage use would probably not be welcomed, as forage is often short.

10. Most of the groups interviewed were in regular contact with extension staff, who, although short of transport funds, appear to be quite active in Kiambu and would be a

reasonably effective way of spreading dissemination messages from the project. Farmer to farmer contact could also be effective, as the area is densely populated. There are a number of strong women's groups especially in Githunguri, and also church groups. All would be valuable contact points for adaptive research or dissemination.

11. In the study area there is evidence of interest in "sugar cane Napier" which is a sweet variety. There is also concern about Napier head smut and it would be worth (though not necessarily in this project) investigating whether there is any correlation between head smut resistance and sugar content.

12. If the team were to test MSVD resistant cultivars in a low incidence area, Village 7 would appear to be a good candidate since it gave universally low scores. However, the disease seems to be erratic in its appearance and the research team has reported that the incidence in Kiambu in the 2001 long rains appeared to be higher than it was during the 2000 short rains season.

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Appendix 1: Guidelines for team conducting RRA activities

Seasonal calendar for the maize crop

INFORMATION SOUGHT

Maize management practices:

- When planted (number of crops and timing)

- What is planted (variety of maize and source)

- How planted and reasons (planting method)

- Use of what is grown, when and why (stover and grain, use for human food, sale or livestock feed)

- Weeding practices, choices and constraints (when, how, use made of weeds, labour constraints)

- Practices carried out for reasons of disease control (at main stages of the crop)

PROCESS

1) Break the ice with self introduction and introduction of the topic - explain that maize and dairy cattle are to be discussed

2) Ask how many maize crops are usually grown in a year

3) Describe the calendar and list the months of the year horizontally

4) Ask for a member of the group to assist in taking notes

5) Ask for a list of activities related to the growing of maize, mark them on the calendar - if there are several/continuous crops, try to capture this.

6) Probes for planting practices

   a) What varieties are grown

   b) Why these varieties

   c) Any dressings applied, and why

   d) What spacing

   e) How many plants per hill

   f) Why this density/seeds per hill

   g) Are fertilisers/manure used

   h) What type and how much

7) Probes for weeding practice

   a) Why the timing of weeding (may be related to labour)

   b) Method of weeding

   c) Who does the weeding (women, men, children, hired labour, family labour)

   d) What are the common weeds - write a list separately to the calendar - write down the local names but make sure the weed can be identified.

   e) What is done with the weeds (which ones are fed to livestock)

   f) What might affect the decision on whether to feed or not to feed

8) Probes for thinning

   a) How do you decide when and what to thin

   b) What is done with the thinnings

   c) What might affect the decision on whether to feed to livestock

9) Probes for harvesting

   a) Is the maize harvested green or dry

   b) Why the choice of green or dry

   c) In what state is stover harvested, green or dry

   d) What is done with stover

   e) What might affect the decision on whether to feed to livestock

Seasonal calendar for forages fed to cattle

INFORMATION SOUGHT

Forage fed to cattle

- Importance of different forages at different times of year (weeds in crop, weeds off crop, maize thinnings, stover, Napier from farm, purchased forages)

- Seasonal shortages and solutions applied

PROCESS

1) It is assumed that this calendar will be run immediately after the maize calendar, or on the same day with a short break between. The calendar for forages should be drawn directly below that for maize so that comparisons can be made. Obviously, it would not be done for groups that do not keep cattle.

2) Explain that a calendar is now going to be drawn for all types of forages fed to dairy cows, those grown on the farm or bought in, including any weeds that are fed.

3) Ask for a list of forages fed to cattle. Explain that you want a detailed list including the source of the forage. For example, if weeds are fed, you are interested in knowing where they come from, whether from the maize crop or from other parts of the farm. List forages from different sources as different items. If more than 10 are listed, ask for the most common to be selected. NB the note-taker should note the full list as well as the shortened list that is finally used for the calendar.

4) Ask in which month each forage is fed and mark it on the calendar.

5) Explain the process of proportional scoring. Assuming that all of the forages fed in each month have a total score of 10, how much of that total would be allocated to each of the forages fed in the month.

6) Ask for the scores and note them on the calendar. If there is much discussion or dispute about a score this may mean that one score applies to some members of the group and another to other members. In this case, record both and try to find out which applies to most people.

7) Record the months when forage is very scarce and find out why.

8) Finally, compare the maize and forage calendars so that you are clear about he timing of inputs from the maize crop to the cattle (thinnings, stover, leaves, weeds) and from the cattle to the maize crop (manure). Draw arrows between the two calendars in months when the inputs occur and ask the group to confirm that these are correct.

Matrix of weeds

Perceived impact of different weeds on maize and stover yield

Cost and difficulty of control of different weeds

PROCESS

1) Ice breaking - self re-introduction (this activity will be done on the second visit) - explain that we would like to discuss weeds, pests and diseases in the maize crop and will start with weeds.

2) Ask if one of the group would like to assist with recording

3) Refer to the list of weeds that was previously listed when making the seasonal calendar, and check which ones are found in the maize crop. If there are more than ten, ask for the ten most common. Write down whichever local name for the weed is given but make sure that you get a good description, or ask to see a sample of the weed, so that it can be identified.

4) Write the list of weeds in the maize crop on the left side of the paper

5) Add two more column headings. (only two, not the whole matrix!). Don't take too much space, there are four more columns to come.

	Long rain crop	Short rain crop
Weed		
Weed		
Weed		
Weed		
Weed		
Weed		
Weed		
Weed		
Weed		
Weed		

For each weed, find out whether it is seen in the long rain crop, the short rain crop or both, and tick the appropriate boxes. If a weed is more common in one season than another, note it.

6) Add four more columns to the matrix

	Long rain crop	Short rain crop	Without control, how much is grain yield reduced	Without control, how much is stover yield reduced	Difficulty of control	Expense of control
Weed						
Weed						
Weed						
Weed						
Weed						
Weed						
Weed						
Weed						
Weed						

Explain that you want to put a score in each box. 1 means that the weed does not have much effect, 5 means that it has a lot of effect, 2-4 are in between.

GO DOWN EACH COLUMN IN TURN asking for a score for each box. This is faster than going across the rows and it allows the scores down each column to be compared so that you can be sure that the group is thinking carefully about the scores. Probe if there seem to be two scores - for example if a score is very high for some types of farmer and very low for others - in this case record both with some explanations.

You are interested on the effect that the weed would have on yield if it was not controlled. The group may have some experience of this if there are times when they do not or cannot weed.

The difficulty of control means - how difficult is it for them to get rid of. Does it require frequent weeding? Is it tough to pull out? Does it grow very fast? Can it be killed with herbicide?

The expense of control relates to the cash that they need to spend in controlling it. Do they need to buy herbicide or hire labour?

7) Probes. Make sure that somewhere in the discussion these things come out:

   a) if there is a big yield effect, why is it? If a yield effect on stover, does it affect quantity, quality or both?

   b) If there is a big expense, what are they spending money on (Chemicals, labour)?

   c) If a weed is very difficult to control, is this a characteristic of the weed or the weeding practice?

Matrix of pests and diseases

Perceived impact of different pets and diseases on maize and stover yield

Cost and difficulty of control of different pests and diseases

PROCESS

1) It is assumed that this follows the weed matrix so no ice breaking needed - just explain that you would now like to do similar exercise for pests and diseases.

2) Ask for a list of the pests and diseases that affect the maize crop and record it. Some will have recognisable names. Others may have names known to the farmers but not the scientist - in this case, get a detailed description or ask to see an example so that the pest or disease can be identified later. In some cases the farmer may only be able to describe the symptoms.

3) If there are more than 10 pests and diseases, ask which are the most common. These will form the left side of the matrix. Write them in a column on the left side of the paper.

4) Add two more column headings. (only two, not the whole matrix!). Don't take too much space, there are four more columns to come.

	Long rain crop	Short rain crop
Pest/disease		
Pest/disease		
Pest/disease		
Pest/disease		
Pest/disease		
Pest/disease		
Pest/disease		
Pest/disease		
Pest/disease		
Pest/disease		

Go down the list of pests and diseases and tick which ones are seen in the short and long maize crop. If a pest or disease is more common in one season than another, note it.

5) Add four more columns to the matrix

	Long rain crop	Short rain crop	Without control, how much is grain yield reduced	Without control, how much is stover yield reduced	Difficulty of control	Expense of control
Pest/disease						
Pest/disease						
Pest/disease						
Pest/disease						
Pest/disease						
Pest/disease						
Pest/disease						
Pest/disease						
Pest/disease						

6) Explain that you want to put a score in each box. 1 means that the pest/disease does not have much effect, 5 means that it has a lot of effect, 2-4 are in between.

7) GO DOWN EACH COLUMN IN TURN asking for a score for each box. This is faster than going across the rows and it allows the scores down each column to be compared so that you can be sure that the group is thinking carefully about the scores. Probe if there seem to be two scores - for example if a score is very high for some types of farmer and very low for others - in this case record both with some explanations.

You are interested on the effect that the disease would have on yield if it was not controlled. The group may have some experience of this if the disease pest is hard to control.

The difficulty of control means - how difficult is it for them to get rid of. Is there a chemical or cultural practice that hey are aware of that will control the problem? If there is, do they use it, and if not, why not?

The expense of control relates to the cash that they need to spend in controlling it. Do they need to buy chemicals or hire labour?

8) Probes. Make sure that somewhere in the discussion these things come out:

   a) If there is a yield effect on stover, does it affect quantity, quality or both? Would loss of quality affect the feed value of the stover?

   b) If there is a big expense, what are they spending money on?

   c) If there is a big difficulty of control score, is there no control process that works, is it hard to get hold or, or do they choose not to use it?

Disease and stage of crop calendar

INFORMATION SOUGHT

For MSV and one other pest or disease of choice:

- stages of the crop when it is seen
- control practices applied
- understanding of the epidemiology

PROCESS

1) Explain that you would like to find out more about MSV.

2) Ask for the stages of the maize crop and record them on a time line

e.g.

Planting	Knee high	Invisible tassel	Flowering	Mature cobs

3) Ask at which stages MSV attacks and how often it attacks at each stage, scoring from 1 (seldom) to 5 (very often) Record the amount as a histogram e.g.

Planting	Knee high	Invisible tassel	Flowering	Mature cobs
	x	x	x	
	x	x	x	
		x	x	

4) Ask if any control actions are taken before the disease is seen or when it is seen, and note these actions on the calendar.

5) Ask if the group knows how it gets into the crop

6) Is it ever seen on any other plants or weeds. If so, is anything done about this?

7) Make a histogram for each of:

   a) the effect on grain yield of MSV at each stage when it is seen

   b) the effect on stover yield of MSV at each stage when it is seen.

8) Say that you would like to repeat the exercise for one more pest or disease that is important to the group. Ask them to choose one, then repeat the exercise.

Appendix 2: Complete list of weeds mentioned by the groups

Amaranthus spp
Black Jack (*Bidens pilosa)*
Chenopodium spp
Commelina spp
Couch grass *(Digitaria abyssinica)*
Cyperus spp (nut grass)
Datura stramonium
Devil's thorn (*Emex australis)*
Digitaria velut.
Eracustrum arabicum
Gakaraku
Gallant soldier (*Galinsoga parviflora)*
Galium spurium
Goat weed
Kageni
Kanumira
Mukunguni
Muthunga
Other grass
Oxalis spp
Oxygonum sinuatum
Pennisetum clandestinum (Kikuyu grass)
Portaluca oleracea
Stellaria media
Tagetes minuta