 Venue: Agriculture Information Centre (AIC), Kibate, Nairobi, Kenya

Chair: Dr Jackson Njuguna and Prof Emyr Owen

The meeting commenced at around 0900 and closed around 1630. A copy of the Agenda is attached as Appendix 10. All participants were required to register on arrival. All were provided with a pack containing the agenda, a copy of the project's log frame, notepad and pen and a literature request form so that participants could request copies of the various reports and publications produced by the project. The following leaflets were also provided:

- project information leaflet (revised 2004),
- leaflet for farmers on project's outputs (first produced 2004)
- an advisory leaflet on maize streak virus disease (revised 2004 from earlier version)
- leaflet for farmers from Freshco Seeds on the newly released maize cultivar, KH521.

Lunch and refreshments were provided at the AIC restaurant and if required, the expenses including per diems of Kenyan participants were reimbursed. A group photograph was taken during the day. A list of participants is attached in Appendix 1.

Session A. Introduction

1/2. Welcome
Dr Jackson Njuguna welcomed participants to the Stakeholder meeting and all participants introduced themselves by name and affiliation.

Dr Joseph Ochieng (Assistant Director of KARI in charge of food crops at KARI headquarters) welcomed participants on behalf of the Director of KARI to the KARI Agricultural Information Centre. He mentioned how the project followed on from previous work and highlighted the role of government policy. Pests damaged up to 46% of crop output impinging on grain and forage. The government and KARI see IPM as the way forward. Information on IPM must be disseminated to stakeholders and that must include policymakers – in particular the Parliamentary Select Committee on Agriculture. It is also essential for researchers to multiply dissemination routes rather than only dealing with small groups of farmers. He asked "What is your exit strategy?" and would like to be able to report on that to his superiors.

3. Objectives of project and meeting
Dr Alistair Murdoch highlighted the project's logframe and objectives. The immediate context of the project was in Kiambu District, which has a population of 744010, and where dairy livestock ownership is a crucial element in poverty alleviation. There is insufficient land for grazing so that 48% of 189709 households stall feed dairy cattle.

Importance of maize as forage for smallholders in Kenya was therefore emphasised leading to this project’s studies of the impact of weeds and diseases on forage yield and quality. Impacts were assessed both from the point of view of farmers’ perceptions and through experimental studies.
4. Description of methods. RRA, Longitudinal Study, On-station research, Participatory on-farm research, Training and Dissemination

Dr Jackson Njuguna explained the wide variety of methods used to achieve the project’s outputs. The first of these was a Rapid Rural Appraisal, which set the scene for the rest of the project, highlighting the importance of maize as a source of forage, supplying 24% of forage or 29% if weeds from the maize crop are included. Maize streak virus disease was also identified as the main biotic constraint to maize production in Kiambu. Further socio-economic studies arose from that as a longitudinal study. This study provided supporting evidence for the parallel experimental programme on the maize production and crop protection system and data on the use and trade in resources. Most important was the use and trading of maize forage and manure and management for control of Maize streak virus disease and weeds. On station research was carried out in five growing seasons at KARI Muguga and at the Farmer Training Centre, Waruhui. Participatory on-farm research was also carried out in Githinguri and Kamburu. All activities had a training and dissemination component including farmer exchange visits – including one to Vihiga to see the Push-Pull habitat management system for maize stalk borer control in action. Farmer field days were held at Muguga in February 2002 and at Waruhui in January 2004. A training day specifically for extension staff was also held in January 2004.

The availability of the project’s leaflets was emphasised and participants encouraged to return the literature request form included in their registration packs.

B. Scope for alleviating seasonal forage shortages using Crop Protection Technologies

5.1 Controlling maize streak virus disease to improve forage yield

Ben Lukuyu (ILRI graduate Research Associate on the project) summarised results of four seasons’ research into effects of MSVD on forage yield and quality. His Powerpoint presentation is appendix 3. Results on artificial infection trials showed benefits of the resistant cultivar KH521 and risks of early infection to susceptible cultivars. Delaying planting date in on-farm trials also showed advantages in some seasons showed some benefits of the resistant cultivar PAN67 when natural infection rates were high and there was some suggestion that delayed planting could lead to greater infection. Interestingly the local landrace Gikuyu showed tolerance of MSVD in terms of grain yield but not for forage.

5.2/3 Promotion and uptake of MSVD resistant cultivars in Kiambu

Following on from Mr Lukuyu’s results demonstrating the benefits of cultivars resistant to MSVD Mr Bernard Omega of East African Seeds described the MSVD resistant cultivar PAN67, also known as “African Queen”. On a question about forage, PAN67 is early maturing with fast dry down but long stay green characteristics. On a question about there being too many varieties and all are “the best”, it was answered that the aim is to let farmers try a range of varieties and see what they think is best. Several then commented that there was no opportunity to compare and that disdtribution is a problem. Dr Njuguna indicated that KARI can help with distribution.

A leaflet on the characteristics of KH521 was also available.

Dr Jane Ininda from KARI Muguga then described the biological considerations and progress in breeding new cultivars emphasising the need to consider adaptation to agro-ecological zone and resistance to a range of pests and diseases including MSVD (Appendix 4).

6 Controlling weeds to improve forage yield

Dr Jedidah Maina summarised results from the longitudinal study and field experimental work on weeding regimes. A shortened version in included in Appendix 5.

Handweeding was often more expensive than herbicides but difference less evident at Kamburu and in Long rains 2003. Delaying second weeding to feed weeds to animals did not reduce forage or grain. Quality of weeds as forage was variable: high in short rains 2001 but not in the long rains 2002. But if weeding is delayed so they can be used as forage, caution is advisable to minimise weed seed influx. Leaving patches unweeded will cause greater problems in the next crop.
A stakeholder highlighted the need to ensure that any recommended treatments (especially those involving chemicals) are safe in terms of pesticide residues not only for humans but also for livestock - [the livestock eat crop products much earlier than humans].

7.1 Push-pull system for maize stem borer control and improving forage yield
Dr Francis Muyecko of ICIPE explained principles behind the push-pull habitat management system (see Appendix 7). Push-pull technology offers a useful contribution to control of stem borers (and weed suppression by the Desmodium) while crops produced address food and forage needs. Important points for farmers in Kiambu are:

*Desmodium* interrows are not needed between every pair of maize rows. The effect of *Desmodium* is retained with one row in every three or five. So other intercrops such as beans may be compatible with the system.

*Desmodium* provides a high quality forage which can be mixed with Napier. The Napier and *Desmodium* can be cut as required provided one tall row of Napier remains around the maize crop at all times.

The Napier cultivar does not appear to be important but this needs verifying for the Napier head smut resistant cultivar, Kakamega 1, and also for a wider range of agro-ecosystems.

7.2 Participatory studies of the push-pull system for maize stem borer control
Dr Sam Njihia explained the trials carried out by two farmer groups (appendix 7). The Kamari womens' group set up comparative trials at Waruhui Farmer Training Centre and the Karweti farmers' group on one of their own holdings. Establishing *Desmodium* proved unreliable by seed and transplanting of vines was found more appropriate on the sloping fields of Kiambu. A major challenge was adaptation of the system to the rotations practised in Kiambu. Stem borer incidence was low but there was some evidence of a reduction in stem borers in push-pull plots. Participatory budgets are reported under agenda item 9.

8 The potential of manure in transmission to subsequent crops of spores of maize head smut disease and weed seeds after feeding livestock & composting
Jackson Njuguna reported (Appendix 8) that the RRA and longitudinal studies indicated that some farmers fed flowering weeds to dairy animals while other farmers fed smutted maize forage to their dairy animals. The question was: will weed seeds and spores survive the ingestion and composting?

Three steers were fed a mixture of seeds of five common weeds and teliospores of maize head smut. Animals were being fed with a teaspoon daily. Dung was collected for composting and drying. Spore survival was assessed by applying dung/compost to soil in pots and assessing incidence of head smut in a susceptible maize cultivar growing in pots. Weed seed survival was assessed by assessing seedling emergence from dung/compost applied to soil in seed trays over six months.

Some seeds of *Amaranthus* survived consumption and composting for three months, but the other weed species and the spores of head smut, did not.

9. Forage conservation especially in relation to push-pull technology
Dr David Miano Mwangi gave an evaluation (Appendix 9) of the push-pull technology in conjunction with the Land O' Lakes' small scale (polythene tube) silage making system, based on participatory budgets carried out with Kamari and Karweti farmer groups.

Budgets showed the expected high start up costs of the push-pull system, but also that losses were associated with current strategy as well if all inputs including labour are costed. The push-pull system is expected to become viable in the longer-term once the Napier and *Desmodium* become more productive. Viability in the short-term could also be achieved when combined with ensiling the extra forage for use in the dry season due to the very high value of high quality forage in the dry season.

10. Summary
Dr Alistair Murdoch summarised the main scientific and technical conclusions of the project and Dr Peter Dorward their economic implications for small-scale farmers.
C. Dissemination and Training

11. Dissemination and training activities
Francis Musembi summarised dissemination and training activities including two farmer field days, farmer exchange visits, participatory on-farm research, training of extension workers and various publications, a project website and project leaflets.

The first farmer field day on 27/Feb/2002 at KARI-NARC-Muguga, was attended by about 70 farmers. The second, on 28/Jan/2004 at Waruhiu FTC was attended by 208 (including 185 farmers)

Field days exposed farmers to technologies promoted by the project and provided ongoing contact with the farmers who participated in the RRA and longitudinal surveys. Farmer feedback was obtained by questionnaires.

At the 2004 field day, 131 out of 185 farmers completed questionnaires. Farmers preferred cultivars KH521 and Pan67 on account of yield and MSVD resistance and Pioneer 3253 for smut resistance. For the push-pull system, farmers also preferred the Kakamega 1 Napier grass variety on account of its resistance to Napier Head Smut.

Twelve farmers from Githunguri were also taken to Vihiga on 6-8 Nov 2002 to see the push-pull system in action & assess its possible application to their farms in Kiambu district. Feedback from the farmers confirmed that stem borers were a problem in Kiambu district and that the push pull system was applicable because of the way it linked dairy and food production.

Farmer exchange visits also took place in Kiambu.
1. The farmers’ group (20 farmers) in Kamburu visited the Kamari Women’s Group at FTC Waruhui on 4/7/03 to view the push-pull plots they had set up after visiting Vihiga. The push-pull system and also Desmodium were new to farmers. After seeing the plots, the Kamburu farmers were interested in silage from Napier and requested Desmodium vines and headsmut resistant Napier

2. Kamari (13 farmers) & Karweti (9 farmers) farmers’ groups made a reciprocal visit to the on farm weeding regimes/MSVD trials at Kamburu on 13 August 2003. They met nine farmers from the Kamburu group. Farmers could see that MSVD was more pronounced in H511 compared to Pan67, but were concerned about availability of seed of Pan67 in the market and the taste of resistant cultivars.

3. Participatory on-farm research was done with farmers into weeding regimes at Kamburu & FTC and into the push-pull system at FTC (Kamari) & Karweti.
Activities done jointly with farmers included planning - seasonal calendar highlighting activity, when, who, inputs needed & outputs obtained, laying out experimental plots, planting, weeding, harvesting, participatory budgeting, scoring for stem borers & MSVD, together with taste trials for consumer preference with Pan67 & H511.
Feedback included a preference for Pan67 compared to H511 for taste & grain size.

Uptake of technologies is evident in that farmers (Kamari & Karweti) have taken Desmodium and Kakamega1 canes for planting in their farms; purchased have bought 129 packets of KH521 to plant on their farms while 45 packets of KH521 were distributed during field day

4. Training of 26 extension officers from six divisions of Kiambu district extension workers took place on 27/Jan/2004 at Waruhiu FTC. Objectives were to sensitize them to technologies promoted by the project and then to encourage officers to pick & prepare an implementation strategy for the most relevant technologies in their respective area.

The first ranked technologies by division were push-pull (Kiambaa and Kikuyu divisions), head smut of maize and Napier (Limuru and Githunguri divisions), forage conservation (Ndeiya division) and MSVD resistant cultivars (Lari division).

5. Outputs of the project are also being disseminated by various publications. MSc and PhD theses are in process; papers have been presented in international conferences; two project leaflets have been published and a project website has been set up.
12. Group discussions
Dr David Miano then led the group discussion session in which participants were split into three groups. Each group was asked to discuss the following three questions:
A. What are the key activities and issues for encouraging uptake?
B. What could you or your organisation do to encourage uptake?
C. Are there any other issues that need to be taken into account?
Each group then provided feedback in a plenary session.

Notes are given here in the order groups presented at the workshop.

GROUP 3
A. Key Issues (not listed in order of importance)
1. High MSVD – Action needed: plant resistant varieties
2. Forage shortage – Action needed: promote forage conservation
3. Napier headsmut – Actions needed: plant resistant variety; implement push-pull
4. Headsmut of maize – Action needed: compost animal manure
5. Stemborer control – Action needed: apply push-pull

B. Encouraging uptake
Demonstrations including field days, farmer/staff tours, farmer field schools

C. Other issues to be taken into account
Availability of resources including availability of demonstration materials, funds to establish FFS and transport and subsistence for extension staff.

Question: Given that the project is ending are there other links which you can use to carry on the work?

Question: To what extent will the seed companies take these technologies to farmers? (Note seed company representative had left by this stage)

Comment by KIOF representative: It will be easy for us to integrate the work into our ongoing activities.

GROUP 2
A. Key Issues
Intensify Farmer Field Schools, demonstrations of technologies and training of extension
Establish bulking sites for fodder materials (Kakamega 1 and Desmodium)

B. Encouraging Uptake
Use of more media is needed to reach a wider audience including radio programmes, newspapers (e.g. Horizon in The Nation). Also, produce more leaflets and posters using more than one language.
Use FFS approach and CBOs to enhance farmer to farmer dissemination (para-professionals)
Link with other community awareness programmes such as those on HIV/Aids and gender issues.
Visit to research and demo sites, e.g. ICIPE and KARI/ILRI
Validation should be carried out for remaining work
Organisational issues to encourage uptake by particular organisations:

Extension
They need further sensitisation to technologies and other extension staff need to be trained.
They could distribute dissemination materials and link farmers with other farmers and organisations to obtain more information.

KARI/ICIPE
Could be involved in training others, backstopping activities, making planting materials available and producing additional dissemination materials.
C. Other issues to be taken into account

There is a need to involve a wider range of stakeholders, e.g. seed suppliers and higher level extension managers; provide facilitation for dissemination activities; build more capacity in terms of personnel by e.g. short courses, MSc programmes and international workshops.

Pack sizes for various materials need to be reduced to make more affordable, e.g. maize, Desmodium.

Links with other community based awareness programmes should incorporate the activities in their programmes.

Question: How do we include/involve the high level extension managers, will a leaflet do?
Answer: The importance of the project contacting senior extension staff and of workshop participants feeding back was stressed.

Comment: Reference to ‘para-professionals’ means training farmers so that they can train others. They are para-professionals because they are not fully professional.

GROUP 1

A. Key Issues

More field days and demos for all stakeholders involved; encourage farmer-to-farmer visits; use of farmer groups/FFS; researcher follow-ups to identify researchable constraints; bulk and made available planting materials e.g. Desmodium, Napier variety Kakamega I, KH521.

B. Encouraging uptake (FTC, KIOF, MOA)

FTC - field days; residential courses; offer facilities for training.

KIOF - Incorporate technologies in the teaching curriculum for farmers and students

LAND-O-LAKES - demonstrations (forage production and conservation); examine soil fertility and environmental issues though ‘push-pull’.

C. Issues to be taken into account

Land sizes (relatively small in Kiambu);

Cost implications of the technologies including labour-issues

Extension back-up/human resource capacity building (currently staff/farmer ratio is 1:1000)

Development of training materials, e.g. leaflets, brochures, handbooks (easy to use by farmers)

Technology niche targeting (identify the problem and choose an appropriate technology to solve it). Niches could include pest control, forage supply or land size. For example in one area, push-pull may solve the problem of forage shortage but in another it may be appropriate for stemborer control.

Comment: Not many extension staff are trained or have adequate information on the technologies.

Question: What is the best way to bulk the planting materials?

Answer: The best way is for a farmer to volunteer some land under which to put the material. The issue is not obtaining the land but the seed. Another issue is the high cost of seed for Desmodium in seed companies.

Question: Who runs the bulking sites?

Answer: Farmers are being taught about cost sharing and therefore the issue of management is not an issue. Farmers are always willing to contribute. Even FTC is still available for farmers.

Answer: Introduction to the FFS would also be a good idea to explore instead of waiting for forces of supply and demand to take its course.

13. Proposed ongoing dissemination in 2004 by R7955 team

Dr Dorward announced that additional funding is likely for the following objectives:

1. To complete the dissemination process of outputs of R7955 to our current farmer groups in Kiambu district and to evaluate uptake, and
2. To train and support existing and potential promotion partners for sustainable and wider dissemination of outputs of R7955 to maize-dairy farmers in the Central Kenyan Highlands after the conclusion of the project.

- Activities would be focussed around a week-long training workshop for up to 20 participants from various promotion partners. Participants are expected to come from NGOs, government extension service, farmer field schools and producer groups, which should be willing to field-test IPM for maize-forage dairying with at least one farmer group.

The workshop will include training in IPM for maize forage dairying in order to alleviate seasonal forage shortages. Teaching methods would include taught sessions and seminars and field visits to one or two farmer groups linked with R7955 and demonstration trials. Content would include maize streak virus disease (control using resistant cultivars), maize stalk borer (control using push-pull habitat management system), weeds (chemical and non-chemical control options) and maize head smut (management options for control).

Additional supporting topics relevant to forage crops and alleviation of seasonal forage shortages will include propagation and management of Desmodium and small scale forage conservation methods using polythene bag technology.

Training in relevant participatory approaches including participatory budgeting for exploring how technologies can fit into complex cropping systems and for designing participatory trials.

14. Closing remarks

Dr Gitonga (Director of KARI-NARC-Muguga) closed the meeting emphasising the importance of the outputs of the project to small-scale maize-dairy farmers.
### Appendix 1: List of Participants

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<tr>
<th>NAME</th>
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<tr>
<td>Joseph Ochieng</td>
<td>KARI Hqts.</td>
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<td>Francis Muyekho</td>
<td>ICIPE</td>
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<td>Grace Mbure</td>
<td>KARI, Muguga</td>
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<td>David N. Kamau</td>
<td>KARI, Muguga</td>
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<td>Martin Kimani</td>
<td>CABI-ARC</td>
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<td>Simon M. Muchigiri</td>
<td>Min. of Agriculture, Kiambaa, Kiambu</td>
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<tr>
<td>Emyr Owen</td>
<td>University of Reading</td>
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<td>Alistair Murdoch</td>
<td>University of Reading</td>
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<td>Peter Dorward</td>
<td>University of Reading</td>
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<td>Ahmed Jama</td>
<td>University of Reading</td>
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<td>David G. Ikua</td>
<td>Waruhui Farmers Training Centre</td>
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<td>Michael Waweru</td>
<td>KIOF</td>
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<td>Margaret Lukuyu-Wambugu</td>
<td>ILRI/MOA&amp;F</td>
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<td>Ben Lukuyu</td>
<td>KARI, Muguga</td>
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<td>James Ndungu</td>
<td>K.F.G.</td>
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<td>Samuel Njihia</td>
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<td>Gilbert Kibata</td>
<td>KARI, NARL Kabete</td>
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<td>Jedidah M. Maina</td>
<td>KARI, NARL Kabete</td>
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<td>F.J. Musembi</td>
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<td>Waweru Gitonga</td>
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<td>Dannie Romney</td>
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<td>David Miano</td>
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<td>Jane Ininda</td>
<td>KARI, Muguga</td>
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<td>G.K. Ngigi</td>
<td>MOA, Ndeiya</td>
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<td>Susan Moywaywa</td>
<td>MOA, Limuru</td>
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<td>Charity Muchira</td>
<td>KARI, NARL Kabete</td>
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<td>Nancy Nguru</td>
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<td>Bernard Lihase Omega</td>
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<td>Josephine Kirui</td>
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<td>F.W. Gikonyo</td>
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<td>J.G. Kibuika</td>
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<td>John Keli</td>
<td>Frescho</td>
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<td>Mary Mburu</td>
<td>University of Nairobi</td>
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<td>Jackson Njuguna</td>
<td>KARI, Muguga</td>
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Photo below of participants by Prof Emyr Owen
Appendix 2: Presentation by AJ Murdoch – agenda item 3

**Project’s aims include...**

- To assess effects of
  - maize streak virus disease and weeding regimes on forage yield and quality
  - the animal on disease and weed transmission
- To quantify
  - Economic implications of diseases and weeding regimes on maize grain and forage.
- To promote
  - Sustainable IPM in maize forage smallholder dairying in the central Kenyan highlands.

**Contracted Project Outputs**

**Original**

a. Effects of maize genotypes, diseases and weeding regimes, on total forage yield, forage quality and seasonal forage availability, quantified.

b. Effectiveness of improved pest management strategies (i.e. “routing” maize, and weed forage through ruminants [feed & manure compost]) in reducing foliar necrotic diseases, stem borer and weed seed transmission between seasons & increasing forage production, quantified.

c. Economic implications of maize diseases and farmer-acceptable weeding regimes on grain & forage yield, quality and seasonal availability for smallholder maize-dairy farmers and for landless women livestock farmers, quantified.

d. Extensionists and farmers trained to promote sustainable maize-dairying, including how integrated pest management (IPM) may affect the availability of forage.

**Supplementary in add-on from September 2002**

a. MSVD and weed control strategies developed in R7955 and R7405 and where appropriate the ICIPE habitat management system for maize stem borer control for maize validated by and promoted to resource-poor smallholder maize-dairy farmers in a range of agro-ecosystems

b. Appropriate methods of maize-based forage conservation promoted to resource-poor smallholder maize-dairy farmers.

c. Extensionists and farmers trained to promote sustainable maize-dairying including how integrated pest management may affect grain and forage yields of maize and seasonal availability of forage and livelihoods of resource-poor, smallholder farmers.
Appendix 3: Presentation by Ben Lukuyu – agenda item 5.1

Effects of Maize Streak Virus disease (MSVD) and maize cultivars on forage yield and quality

Presentation
- The problem - MSVD
  - effect on crop
  - how to control?
- Solutions investigated
- Impact of solutions on economics
- Messages to farmers

On smallholder farms, maize not only important source of food, but also source of forage

Background
- Growing maize for food and forage has changed cropping practices:
  - relay cropping
  - harvesting green maize for sale
  - high density planting
  - delayed weeding
- Therefore increasing MSVD

Maize Streak Virus disease
- MSVD is the most important disease limiting maize production in central Kenya
- Grain yield losses due to MSVD range from 25 - 55 %

Leafhopper (Cicadulina mbila)
- the vector of Maize Streak Virus disease

Objectives of study
- Effects of time of infection, cultivar and planting dates on:
  - forage yield
    - plant height
    - shank thickness
    - stover
  - forage quality
    - leaf:stem
    - crude protein
    - fibre
    - grain yield

Farmer perceptions of impact of pests & diseases on stover yield

Farmer scores for difficulty of controlling pests & diseases

Arrows are infection times (14, 35 and 56 days after emergence, plus control)

Impact of MSVD and cultivar on thinnings

Impact of MSVD and cultivar on maize stover

Impact of % infection on thinnings

Impact of % infection on stover

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Impact of % infection on grain yield

Impact of MSVD on thinning protein

Impact of MSVD on stover protein

Impact of MSVD on thinning fibre

Impact of MSVD on stover fibre

Planting date effect on thinning yield

Planting date effect on yield

Effect of cultivar and MSVD on gross margins

Effect of planting date on gross margin

On farm trial

Conclusions 1

• MSVD effect much less with KH 521 than Gikuyu & H 511
• For Gikuyu, MSVD affects grain yield less than forage

Conclusions 2

• Early infection more damaging to forage yield than late infection
• If 100% infection early - disaster!
• If 25% infection early - not a disaster
• MSVD does not decrease forage quality

Conclusions 3

• Later planting - higher MSVD
• Later planting – less forage, less grain

Conclusions 4

• Higher gross margins from KH 521 than H 511 & Gikuyu
• MSVD reduced gross margins more with 25% infection than 100%

Messages for farmers

• Plant MSVD resistant cultivars
• Plant early to reduce risk of MSVD
• If you do have MSVD, yield will be less but forage quality not affected
Appendix 4: Summary of presentation by Dr Jane Ininda – agenda item 5.2

**Development of Maize Varieties Resistant to Pests and Diseases in Kenya**

Dr. Jane Ininda  
Kenya Agricultural Research Institute, P.O. Box 30148, Nairobi, Kenya

Over 80% of Kenyan population depends on maize as the major food crop. The per capita consumption is 125 kg per annum. The total production is about 2.3 million tons, with 70-80% of maize produced by small scale farmers Kenya. Several factors that include biotic and abiotic constraints; and limited utilization of agricultural technologies and improved seeds threaten maize production in Kenya. Pests and diseases account for 35% of the total yield losses in maize in the world while more recent studies show insects alone account for 35% yield losses in Kenya.

For the past forty years, maize improvement in Kenya has emphasised high yielding varieties. This produced the popular 500 and 600 series hybrids. Hence disease and pest resistance was not given adequate attention. Consequently epidemics of Maize streak virus disease (MSVD), turcicum blight have resulted and the land area with severe incidences of head smut has increased. The response by the Kenya Agricultural Research Institute has been to breed for resistance to priority pests and diseases of maize in order to develop new cultivars with resistance to foliar diseases. Resistance is perceived as the most cost-effective control option for the risk-prone resource poor farmers in Kenya.

Figure 1. Three year average performance of KH521 (MU99301) for MSVD, yield (t/ha) and Maturity

Figure 2. Susceptibility of new varieties to foliar diseases in National Performance Trials 2001.

Since 1999-2000, a rigorous strategy to improve varietal disease resistance was adopted that took into consideration the diverse maize growing ecologies in Kenya. The objectives of this paper are to highlight improvements for resistance to MSVD, turcicum or northern leaf blight (Setosphaeria turcica; anamorph: Exserohilum turcicum), GLS (Grey Leaf Spot - Cercospora zeae-maydis), common rust (Puccinia sorghi) and stem borers (Chilo partellus).

Figure 1 shows that a newly released hybrid MU99301 (KH521) had a lower MSVD score of 2.5 (mild reactions to streak) compared to the check or the popular variety's score of 4.5 (susceptible to MSV). In addition to resistance and tolerance to MSV, pyramidng for resistance to other foliar diseases is being achieved simultaneously in newly released hybrids. For example MU99232 has resistance to MSVD and showed lower scores (more resistance) for GLS and common rust compared to the check (Fig.2); while MU99085, MU99303, and MU99304 showed resistance to MSV and enhanced resistance to turcicum blight. These improvements in disease resistance have been achieved without compromising the yield levels. Similar improvements have been introduced for stem borers, where one single-cross hybrid was obtained that showed a mean foliar damage score of 3.5 (tolerant) compared to the most popular check, which had a mean foliar score of 9.0 for stem borers (data not shown). Generally newly released hybrids show better disease scores compared to the current popular hybrids for the farmer. This means new cultivars with an immediate potential for deployment could result in better options for the farmer in terms of disease resistant maize varieties that could be used as clean material for forage.
Appendix 5: Presentation by Dr Jedidah Maina – agenda item 6

CONTROLLING WEEDS TO IMPROVE FORAGE

- Impact of weeds on forage yield and quality
  - Farmers’ perceptions
  - On station studies (at Muguga and FTC)
  - On farm studies
- Weeds in the maize crop contribute 5% of annual forage use in Kiambu (Project RRA)
- Integration of MSVD and weed control

Impact of weeds on stover yield

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Stover</th>
<th>Thinnings</th>
<th>Weeds</th>
<th>Forage</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1: weed free</td>
<td>20.5</td>
<td>4.5</td>
<td>5.0</td>
<td>26.0</td>
</tr>
<tr>
<td>W2: unweeded</td>
<td>18.0</td>
<td>4.0</td>
<td>5.5</td>
<td>27.5</td>
</tr>
<tr>
<td>W3: herbicide</td>
<td>19.0</td>
<td>4.0</td>
<td>5.5</td>
<td>28.5</td>
</tr>
<tr>
<td>W4: handweeded</td>
<td>21.0</td>
<td>5.0</td>
<td>5.0</td>
<td>31.0</td>
</tr>
</tbody>
</table>

Flowering weeds at second weeding

- [Data not available for all patches]
- Short rains 2001: 20/26 patches
- Long rains 2002: 18/30 patches
- Main species flowering (in more than 7 patches in both seasons)
  - Bidens pilosa, Commelina spp., Tagetes minuta, Galinsoga parviflora, Amaranthus

Summary of experiments carried out on weeding regimes

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Muguga</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waruhu</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kamburu</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reduction (-) or increase (+) in control costs using herbicides

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Hand weed</th>
<th>Kamburu 2001</th>
<th>Long 2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1: weed free</td>
<td>2 &amp; 3 weeks</td>
<td>-6620</td>
<td>-10000</td>
</tr>
<tr>
<td>W2: unweeded</td>
<td>3 &amp; 4 weeks</td>
<td>+2540</td>
<td>+1100</td>
</tr>
<tr>
<td>W3: herbicide</td>
<td>+2540</td>
<td>+1100</td>
<td></td>
</tr>
<tr>
<td>W4: handweeded</td>
<td>+2540</td>
<td>+1100</td>
<td></td>
</tr>
</tbody>
</table>

Effect of weeding regimes on forage and grain yields (tonnes/ha)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Stover</th>
<th>Thinnings</th>
<th>Weeds</th>
<th>Forage</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1: weed free</td>
<td>2.5</td>
<td>1.5</td>
<td>0.5</td>
<td>2.0</td>
</tr>
<tr>
<td>W2: unweeded</td>
<td>2.0</td>
<td>1.0</td>
<td>0.0</td>
<td>1.5</td>
</tr>
<tr>
<td>W3: herbicide</td>
<td>2.5</td>
<td>1.5</td>
<td>0.5</td>
<td>2.0</td>
</tr>
<tr>
<td>W4: handweeded</td>
<td>2.5</td>
<td>1.5</td>
<td>0.5</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Impact of weeds on digestible dry matter

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Stover</th>
<th>Thinnings</th>
<th>Weeds</th>
<th>Forage</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1: weed free</td>
<td>25.0</td>
<td>5.0</td>
<td>10.0</td>
<td>30.0</td>
</tr>
<tr>
<td>W2: unweeded</td>
<td>23.0</td>
<td>4.0</td>
<td>9.0</td>
<td>28.0</td>
</tr>
<tr>
<td>W3: herbicide</td>
<td>24.0</td>
<td>5.0</td>
<td>10.0</td>
<td>30.0</td>
</tr>
<tr>
<td>W4: handweeded</td>
<td>25.0</td>
<td>5.0</td>
<td>10.0</td>
<td>30.0</td>
</tr>
</tbody>
</table>

Is there an interaction of weeding regimes and MSVD control using resistant cultivars?

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Grain</th>
<th>Thin’s</th>
<th>Stover</th>
<th>Forage</th>
</tr>
</thead>
<tbody>
<tr>
<td>H511</td>
<td>2.26</td>
<td>0.90</td>
<td>2.37</td>
<td>3.27</td>
</tr>
<tr>
<td>PAN 67</td>
<td>5.40</td>
<td>1.14</td>
<td>3.29</td>
<td>4.43</td>
</tr>
</tbody>
</table>

Significance: P=0.001 Trend? n.s. n.s.
P=0.08

Some conclusions

- Weeding twice by hand is often more expensive than herbicides but difference less evident at Kamburu and in Long rains 2003
- Delaying second weeding to feed weeds to animals did not reduce forage or grain
- Quality of weeds as forage was variable: high in short rains 2001 but not in the long rains 2002.
- But caution needed to minimise weed seed influx
- Leaving patches unweeded will cause greater problems in the next crop.
F. N. Muyekho\textsuperscript{1} and Z.R. Khan\textsuperscript{2}  
\textsuperscript{1}Kenya Agricultural Research Institute  
\textsuperscript{2}International Centre of Insect Physiology and Ecology, Kenya

**INTRODUCTION**

- Inadequate quality feed a constraint to livestock productivity
- Small land size/competing enterprises limits planted forages
- Low soil fertility for forage and crop production
- Cereal stemborers (15-40% yield loss in maize)

**What is ‘push-pull’ strategy?**

The strategy involves the use of both trap (pull) and repellant (push) forage plants, so that stemborers are simultaneously repelled from the maize crop and attracted to the trap plants.

### Table 1. Comparison of stem borer Infestation in Push-Pull and Control maize fields in western Kenya

<table>
<thead>
<tr>
<th>District</th>
<th>No. farmers</th>
<th>SB Infest. (%) in Push-Pull</th>
<th>SB Infest. (%) in Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-Nzoia</td>
<td>550</td>
<td>17.1</td>
<td>32.2**</td>
</tr>
<tr>
<td>Suba</td>
<td>375</td>
<td>10.7</td>
<td>21.3*</td>
</tr>
<tr>
<td>Kisii</td>
<td>130</td>
<td>5.0</td>
<td>12.0*</td>
</tr>
<tr>
<td>Rachuonyo</td>
<td>120</td>
<td>6.3</td>
<td>8.1</td>
</tr>
<tr>
<td>Bungoma</td>
<td>150</td>
<td>6.7</td>
<td>7.6</td>
</tr>
<tr>
<td>Busia</td>
<td>130</td>
<td>5.0</td>
<td>6.7</td>
</tr>
<tr>
<td>Vihiga</td>
<td>50</td>
<td>4.1</td>
<td>2.6**</td>
</tr>
</tbody>
</table>

### Table 2. Comparison of maize yield in Push-Pull and Control maize fields in western Kenya

<table>
<thead>
<tr>
<th>District</th>
<th>No. farmers</th>
<th>Maize yield (t/ha) in Push-Pull</th>
<th>Maize yield (t/ha) in Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-Nzoia</td>
<td>550</td>
<td>4.0*</td>
<td>6.8*</td>
</tr>
<tr>
<td>Suba</td>
<td>375</td>
<td>4.1</td>
<td>6.3*</td>
</tr>
<tr>
<td>Kisii</td>
<td>130</td>
<td>2.8*</td>
<td>4.4*</td>
</tr>
<tr>
<td>Rachuonyo</td>
<td>120</td>
<td>2.0*</td>
<td>2.2*</td>
</tr>
<tr>
<td>Bungoma</td>
<td>150</td>
<td>1.6*</td>
<td>1.6*</td>
</tr>
<tr>
<td>Busia</td>
<td>130</td>
<td>2.8*</td>
<td>2.8*</td>
</tr>
<tr>
<td>Vihiga</td>
<td>50</td>
<td>2.5*</td>
<td>2.5*</td>
</tr>
</tbody>
</table>

### Effects of pattern of Desmodium intercropping with maize on stem borer control and yield in 1999

<table>
<thead>
<tr>
<th>Inter-crop pattern</th>
<th>SB Infest. (%)</th>
<th>Number of borers recorded</th>
<th>Maize yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize mono</td>
<td>13.0</td>
<td>46.0</td>
<td>6.0</td>
</tr>
<tr>
<td>1 Dec: 1 mz.</td>
<td>5.3</td>
<td>17.0</td>
<td>6.7</td>
</tr>
<tr>
<td>1 Dec: 3 mz.</td>
<td>6.0</td>
<td>20.7</td>
<td>8.1</td>
</tr>
<tr>
<td>1 Dec: 5 mz.</td>
<td>6.7</td>
<td>18.0</td>
<td>7.6</td>
</tr>
<tr>
<td>1 Dec: 7 mz.</td>
<td>5.8</td>
<td>20.0</td>
<td>7.0</td>
</tr>
<tr>
<td>1 Dec: 9 mz.</td>
<td>10.0</td>
<td>35.2</td>
<td>6.7</td>
</tr>
<tr>
<td>1 Dec: 11 mz.</td>
<td>13.3</td>
<td>45.2</td>
<td>6.6</td>
</tr>
</tbody>
</table>

### Effects of pattern of Desmodium intercropping with maize on stem borer control and yield in 2003

<table>
<thead>
<tr>
<th>Inter-crop pattern</th>
<th>SB Infest. (%)</th>
<th>No. of borers recorded</th>
<th>Maize yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize mono</td>
<td>16.1</td>
<td>18.7</td>
<td>6.8</td>
</tr>
<tr>
<td>1 Dec: 1 mz.</td>
<td>6.2</td>
<td>2.2</td>
<td>7.9</td>
</tr>
<tr>
<td>1 Dec: 3 mz.</td>
<td>4.4</td>
<td>0.6</td>
<td>7.7</td>
</tr>
<tr>
<td>1 Dec: 5 mz.</td>
<td>6.7</td>
<td>1.3</td>
<td>7.1</td>
</tr>
<tr>
<td>1 Dec: 7 mz.</td>
<td>8.3</td>
<td>5.0</td>
<td>7.1</td>
</tr>
<tr>
<td>1 Dec: 9 mz.</td>
<td>10.0</td>
<td>4.8</td>
<td>7.1</td>
</tr>
<tr>
<td>1 Dec: 11 mz.</td>
<td>8.9</td>
<td>8.3</td>
<td>6.8</td>
</tr>
</tbody>
</table>

### Comparison of stem borer predators on maize plants in Push-Pull and Control fields (Lambwe, Kenya 2001)

### Economics of push-pull technology

### Benefits from Habitat Management Project
INTRODUCTION

- RRA results for Kiambu district 2001 ranked stem borers as 2nd in the pest & disease problem ranking
- Attacked plants are stunted or die causing yield loss of 20 – 80%
- Integrated pest management (IPM) strategies available, but efficacy of some not yet proven
- Push - pull system (see agenda item 7.1) is part of this IPM
  - Napier grass produces smells attractive to stemborer moths (pull)
  - Desmodium produces repulsive smells to stemborers (push)

Materials and Methods

- Farmer participatory studies
  - Two farmer groups used
    - Kamari women’s group based at Waruhiu FTC
    - Karweti farmers’ group based at one member’s land in Githunguri
- During the short rains 2003 planting season each group planted Push-pull & control plots

<table>
<thead>
<tr>
<th>Kamari</th>
<th>Karweti</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push/pull</td>
<td>Control</td>
</tr>
<tr>
<td>H511</td>
<td>0.72 (17/2352)</td>
</tr>
<tr>
<td>PAN67</td>
<td>0.64 (15/2352)</td>
</tr>
</tbody>
</table>

Results

Percentage of plants affected by stem borers in each plot of push-pull trial, short rains 2003. (Numbers and total sample in brackets).

- Preliminary observations tabulated above suggests that at both Kamari and Karweti the push-pull plots have less incidence of attack than the controls. Possibly attributable to push pull effect but there is need for proper validation studies since the results are based on one season’s data.
Farmers’ perception of push-pull in the light of other crops in the rotation

- Rotation is a normal farming practice in Kiambu district but other crops in the system include potatoes (Irish & sweet), bananas, tomatoes.
- Farmers believed that the farming practice could accommodate both these rotational crops and the spatial arrangement of the perennial Napier and Desmodium crops required for the push-pull system.
- Farmers were satisfied that the outputs from push-pull units addressed need of both human food and forage.

Unresolved questions about the push pull systems

- The maximum size of the push-pull unit to ensure that semiochemicals involved are effective?
- Napier variety: the variety Kakamega 1, which is resistant to Napier head smut, has not been evaluated for attractiveness to stemborer moths.
- The recommended management (harvesting and cutting back) practices for Napier and Desmodium for optimal results.

Work still needed

- As expected results in the participatory budgets show negative gross margins in the first season of the technology due to setup costs and so longer-term evaluation of costs and benefits is needed. Validation studies should determine how long it will take for gross margins in the push pull systems to turn positive.
- The technology needs adaptation to the crop rotations practiced in central Kenya.
- Technology promoters need to be trained in all of push pull technology including
  - Bulking of desmodium plants using either seeds or vines
  - Economically viable push-pull lay-outs
  - How to introduce farmers to the technology.

MESSAGE

- Push-pull technology offers a useful contribution to control of stem borers (and weed suppression by the Desmodium) while crops produced address food and forage needs.
Appendix 8: Presentation by Dr Jackson Njuguna - agenda item 8

**Cattle manure as a means of dispersal for weeds and head smut of maize**

J. M. Maina and J.G.M. Njuguna

**Introduction**
- RRA and longitudinal studies indicated that some farmers fed flowering weeds to dairy animals
- Other farmers fed smutted maize forage to their dairy animals
- Some farmers were afraid that smutted maize forage was harmful to dairy animals
- Faced with the forage shortage problem, some farmers opted to remove only the smutted parts of the maize plants and to feed the animals with the rest.
- Smutted parts (usually tassel and cob) are removed but left on the ground, contaminating the field even more.
- Two types of smut occurs often in maize namely common smut (caused by *Ustilago maydis*) and head smut (caused by *Sporisorium reilianum*), the latter being more destructive than the former.

**Materials and methods**
- Experiments conducted in 2002 and 2003 to investigate the passage of weed seed and smut spores through the animal gut and the effect of composting the dung
- Three Holstein steers weighing about 700 kg were used.
- Animals were fed on Napier grass for one week before the treatment.
- Treatment consisted of 400g mixture of maize germ and bran on to which 250g of smut spores and 250g of weed seed of each of five weed species: Amaranthus spp., Bidens pilosa, Erucastrum arabicum, Galinsoga parviflora and annual grasses.
- The treatment ration was given to the animals daily for 3 weeks.
- The dung from the three steers was collected daily and pooled together and then split into two.
- One heap was composted for three months and the other heap spread on the floor to dry.

**Results**
- Both the weed seed of Amaranthus and the smut spores passed through the gut unharmed. The other weed seed appear to have been destroyed during passage.
- Composting appear to kill all smut spores and most seeds of Amaranthus.

**Transmission of *S. reilianum* spores and *Amaranthus* seed through manure. Spores survival was detected by development of head smut on plants of a susceptible maize genotype. Seed survival was evidenced by emergence of seedlings over at least six months.**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% maize plants smutted</th>
<th>Number of germinated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh cow dung (T1)</td>
<td>43</td>
<td>3.75</td>
</tr>
<tr>
<td>Dried cow dung(T2)</td>
<td>14</td>
<td>37.25</td>
</tr>
<tr>
<td>Composted cow dung(T3)</td>
<td>0</td>
<td>9.75</td>
</tr>
<tr>
<td>Positive control (T4)</td>
<td>53</td>
<td>438</td>
</tr>
<tr>
<td>Negative control (T5)</td>
<td>0</td>
<td>1.5</td>
</tr>
</tbody>
</table>

**Take-home message**
- Although some weeds are good forage for dairy animals, do not feed seeding weeds to livestock.
- Plant maize cultivars that are resistant to head smut if the disease occurs frequently.
- Do not feed smutted maize forage to cattle, but if you do, then compost cow dung for at least three months before use.
- If you buy manure from afar look out for new weeds.
Participatory Budgets in Forage Technologies

Mwangi D. M., Methu J. N., Maina J. W, Nyanyu G. Kirui, J. and Njuguna J.

Introduction
i. What are participatory budgets?
ii. Why we think they are important?
iii. Examples of how they were used in:
   1. Push and pull technology (Karweti and Kamari)
   2. Fodder conservation (partial budget)
iv. Conclusions

What are participatory budgets (PB)?
A tool which examines a farmer’s use and production of resources over time for a specific enterprise - i.e. control of stem borer in maize or forage conservation in dairy.
   i. Analyse farmers existing activities, resource use and production
   ii. Explorer implication of changes in resource use
   iii. Compare different enterprises
   iv. Plan new enterprise

Format for PB
Example: Push-pull in Karweti
i. Used to compare a change in the use of resources - push-pull to control stem borer
ii. Current practices (Gichichio)
iii. Push pull (New technology)
iv. Two seasons – Long rains 2003 (kimera kia njahi) and short rains 2003 (Kimera kia mwere)

Activities and inputs for control (current practice) by month (long rains)

<table>
<thead>
<tr>
<th>ACTIVITIES</th>
<th>INPUTS</th>
<th>OUTPUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 2003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land preparation</td>
<td>Labour 44.4 mandays @100 KSh/day = 4440</td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>Labour 66.7 mandays @100 KSh/day = 6670</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pan67 - 25kg seed@150 KSh/kg = 3750</td>
<td></td>
</tr>
<tr>
<td></td>
<td>H511 - 33.3kg@ 135 KSh/kg = 4500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bean seed 22.2 kg@ 40 KSh/kg = 889</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fertilizer – DAP 88.9 kg @ 25 KSh/kg = 2222</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>Labour 22.2 mandays @100 KSh/day = 2220</td>
<td></td>
</tr>
<tr>
<td>1st Weeding</td>
<td>Labour 11.1 mandays @100 KSh/day = 1100</td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>Labour 22. mandays @100 KSh/day = 2220</td>
<td></td>
</tr>
<tr>
<td>2nd Weeding</td>
<td>Labour 33. mandays @100 KSh/day = 3330</td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>Labour 22. mandays @100 KSh/day = 2220</td>
<td></td>
</tr>
<tr>
<td>Maize thinning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>Labour: 199.9 mandays @100 KSh/day = 19990</td>
<td></td>
</tr>
<tr>
<td>Harvesting</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SUMMARY OF INPUTS
Labour: 199.9 mandays @100 KSh/day = 19990
Maize Seeds
Pan67 - 25 Kg @ 150 KSh/kg = 3750
H511 - 33.3 kg @ 135 KSh/kg = 4500
Bean seeds
22.2 kg @ 40 KSh/kg = 889
Fertilizer – 88.9 Kg @ 25 KSh/kg = 2222
Total cost (Pan67) = KSh. 26,851.50
(H511) = KSh. 27601.5

SUMMARY OF OUTPUTS
H511
Grain Ksh. 1665
Thinnings Ksh. 10,668
Stover Ksh. 10000
TOTAL KSh 22333

Pan67
Grain Ksh. 15,974.40
Thinnings Ksh. 1665
Stover Ksh. 6,666.70
TOTAL KSh 24,306.10

Gross Margin
Pan67 KSh - (3295.50)
H511 KSh - (5268.50)
### Activities and inputs for push-pull by month (long rains)

#### ACTIVITIES

- **March 2003**
  - Land preparation

- **April**
  - Planting maize
  - Planting beans

- **May**
  - 1st weeding

- **June**
  - 2nd Weeding
  - Watering
  - Desmodium

- **September**
  - Harvesting Napier 1 row

- **October**
  - Harvesting maize
  - [No thinning as only one seed planted per hill]

#### INPUTS

- **March**
  - Labour 44.4 mandays @100 KSh/day = 4440

- **April**
  - Labour 66.7 mandays @100 KSh/day = 6670
  - Pan67: 22.2kg seed@150 KSh/kg = 3333.30
  - H511: 22.2kg @ 135 KSh/kg = 2997
  - Bean seed 22.2 kg@ 40 KSh/kg = 888
  - Fertilizer - DAP 88.9 kg @ 25 KSh/kg = 2222

- **May**
  - Labour weeding 44.4 mandays@100 KSh/d = 4440

- **June**
  - Weeding 44.4 mandays @100 KSh/day = 4440
  - Watering 66.7 mandays @100 KSh/day = 6670

- **September**
  - Labour - 22. mandays @100 KSh/day = 2220

- **October**
  - Labour 44.4 mandays @100 KSh/day = 4440

#### SUMMARY OF INPUTS

- Labour: 588.7 mandays @100 KSh/day = 58870
- Pan67 seed - 22.2kg @150 KSh/kg = 3333.30
- H511 seed – 22.2kg@ 135 KSh/kg = 2997
- Bean seed 22.2 kg@ 40 KSh/kg = 888
- Fertilizer - DAP 88.9 kg @ 25 KSh/kg = 2222
- Manure for Napier- = 6670

- **September**
  - Napier grass - 55.6 loads @. 50 Ksh /load = 2780

- **October**
  - Maize grain
  - H511 - 1000 “tins” @ 40 KSh/tin = KSh 40000
  - Pan67 - 1000 “tins” @ 40 KSh/tin = KSh 40000
  - Stover
  - Pan67 = KSh. 11111
  - H511 = KSh. 8888.80

#### OUTPUTS

- **September**
  - Napier grass – 55.6 loads @. 50 Ksh /load = 2780

- **October**
  - Maize grain
  - H511 - 1000 “tins” @ 40 KSh/tin = KSh 40000
  - Pan67 - 1000 “tins” @ 40 KSh/tin = KSh 40000
  - Stover
  - Pan67 = KSh. 11111
  - H511 = KSh. 8888.80

### Activities and inputs for push-pull – summary only (short rains)

#### ACTIVITIES

- **SUMMARY OF INPUTS**
  - Labour: 338.6 mandays @100 KSh/day = 33860
  - Pan67 seed – 33.3kg @150 KSh/kg = 5000
  - H511 seed – 12.5kg@ 137.50 KSh/kg = 1718.75
  - Bean seed 5.6 kg@ 40 KSh/kg = 224
  - Fertilizer - DAP 91.6 kg @ 25 KSh/kg = 2290
  - Manure - = 32222

- **OUTPUT SUMMARY**
  - Napier Grain Ksh. 6666.7
  - Thin+Stover KSh 8057.2
  - TOTAL KSh 42947.90

#### OUTPUT SUMMARY

- Pan67 Grain Ksh. 10557.2
- Thin+Stover KSh 21333.3
- TOTAL KSh 42115.50

### Activities and inputs for control (short rains)

#### ACTIVITIES

- **SUMMARY OF INPUTS**
  - Labour: 193.9 mandays @100 KSh/day = 19390
  - Pan67 seed - 33.3kg @150 KSh/kg = 5000
  - H511 seed – 12.5kg@ 137.50 KSh/kg = 1718.75
  - Bean seed 22.2 kg@ 40 KSh/kg = 888
  - Fertilizer - DAP 116.7 kg @ 25 KSh/kg = 2917
  - Manure - = 25000

- **OUTPUT SUMMARY**
  - Beans 10224
  - H511 Grain Ksh. 6666.7
  - Thin+Stover KSh 8057.2
  - TOTAL 42947.90

#### OUTPUT SUMMARY

- Pan67 Grain Ksh. 10557.2
- Thin+Stover KSh 21333.3
- TOTAL 42115.50

### Activities and inputs for push-pull (short rains)

#### ACTIVITIES

- **SUMMARY OF INPUTS**
  - Labour: 338.6 mandays @100 KSh/day = 33860
  - Pan67 seed - 33.3kg @150 KSh/kg = 5000
  - H511 seed – 12.5kg@ 137.50 KSh/kg = 1718.75
  - Bean seed 5.6 kg@ 40 KSh/kg = 224
  - Fertilizer - DAP 91.6 kg @ 25 KSh/kg = 2290
  - Manure - = 32222

- **OUTPUT SUMMARY**
  - Napier 29445.4
  - Desmodium 1600
  - Beans 5777.80
  - H511 Grain Ksh. 7112
  - Thin+Stover KSh 19435.50

- **OUTPUT SUMMARY**
  - Pan67 Grain Ksh. 10666.70
  - Thin+Stover KSh 20546.60

- **Gross Margin**
  - Pan67 Ksh - (3064.50)
  - H511 Ksh - (7521.55)
Gross margins over 2 seasons

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cultivar</th>
<th>Long rains</th>
<th>Short rains</th>
<th>TOTAL</th>
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</thead>
<tbody>
<tr>
<td>Push-pull</td>
<td>H511</td>
<td>-(19978.7)</td>
<td>-(7221.55)</td>
<td>-(27200.25)</td>
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<tr>
<td></td>
<td>PAN 67</td>
<td>-(18092)</td>
<td>-(3064.50)</td>
<td>-(21156.5)</td>
</tr>
<tr>
<td>Control</td>
<td>H511</td>
<td>-(5268.5)</td>
<td>-(24966.35)</td>
<td>-(30234.85)</td>
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<tr>
<td></td>
<td>PAN 67</td>
<td>-(3295.5)</td>
<td>-(11081)</td>
<td>-(14376.5)</td>
</tr>
</tbody>
</table>

Participatory partial budget in feed conservation

Methodology
Determine dry period (Months)
Current dry season strategy vs silage making
Determine inputs and cost of current strategy
Buy in grass from coffee estates
Cost per load in dry season = KSh. 250
Requirement: 78 loads in 5 months plus an extra bag of bran per month

Inputs and output

| January | Grass 16 loads @ 250 = KSh. 4000 |
|         | 1 bag of bran = KSh. 260 |

| February| 14 loads @ 250 = KSh. 3500 |
|         | 1 bag of bran = KSh. 260 |

| March   | 14 loads @ 250 = KSh. 3500 |
|         | 1 bag of bran = KSh. 260 |

| August  | Grass 16 loads @ 250 = KSh. 4000 |
|         | 1 bag of bran @ 260 = KSh. 260 |

| September| 16 loads @ 250 = KSh. 4000 |
|          | 1 bag of bran @ 260 = KSh. 260 |

Total - KSh. 20800

Inputs for making silage
Need 9 tubes of approx 400 kg in May or Nov
3 t of forage from push-pull
22.5 m polythene tube @ 110 = KSh. 2475
Molasses 2.5 Jeri cans @ 300 = KSh. 750
5 mandays @ 100 = KSh. 500
Total - KSh. 3725

Scenario 1 - Milk yield remains 8 litres/day with or without forage conservation
Output - KSh 19328
Gross margin without conservation - 19328-20300 = KSh. (972)
Gross margin with conservation - 19328 - 3725 = KSh. 15,603

Scenario 2 - With conservation milk yield increase to 18 litres/day due to more and better quality feed
Output - KSh 38656
Gross Margin: 38656 - 3725 = KSh 34931

Conclusions
Making a loss in push-pull and control
Reduced losses during the second season – reduced labour costs in push-pull
Concerns
Extra costs - watering Desmodium
Extra inputs -
Conservation positive even when output remains the same.
Session A. Introduction and welcome 0830-1000

1. Welcome
2. Introduction to participants
   2.1. Opportunity for all to say who they are and their affiliation and interest in project
3. Objectives of project and meeting (AJM)
   3.1. Agenda note: This final stakeholder meeting of R7955 has the primary purpose of reporting to stakeholders on the overall project and extent to which its outputs have been completed. It follows on from Stakeholder meetings on 11 July 2001 and 30 September 2002. Copies of the minutes of both meetings were circulated, but are also available on the project website. Results and extension messages and implications of all activities will be presented and open for discussion. Opportunities for ongoing dissemination and impact will also be explored.
4. Description of methods. RRA, Longitudinal Study, On-station research, Participatory on-farm research, Training and Dissemination (Jackson Njuguna)

Refreshments break and group photograph 1000-1030

Session B. Scope for alleviating seasonal forage shortages using Crop Protection Technologies 1030-1120

5. Controlling maize streak virus disease to improve forage yield 1030-1100
   5.1. (Ben Lukuyu)
   • The importance of MSVD in Kiambu (RRA/longitudinal results)
   • Impact and economic consequences of MSVD on forage from maize
   • Why date of infection gives different results on-station and on-farm
   • Impact of agronomy (fertiliser, planting density, planting date)
   • Acceptability trials for PAN 67 and KH521
   • Recommendation: use of resistant varieties (BL)
   5.2. Promotion and uptake of MSVD resistant cultivars in Kiambu
      5.2.1. KH521 (Muguga 1) (Freshco Seeds) 1100-1105
      5.2.2. PAN67 (Pannar Seed Company) 1105-1110
   5.3. Development of MSVD resistant cultivars at KARI Muguga (Dr Jane Ininda) 1110-1120

6. Controlling weeds to improve forage yield (Jedidah Maina) 1120-1150
   • Controlling weeds to improve forage
   • The context (RRA/longitudinal) impact of weeds
   • Impact and economic consequences of weeds on forage from maize
   • Interaction of weeding and MSVD
   • Recommendations: regimes, late weeding
   • Promotion and uptake of herbicides using small packs

7. Push-pull system for maize stem borer control and improving forage yield 1150-1205
   7.1. The push-pull system (Dr Francis Muyecko, ICIPE) 1150-1205
   7.2. On-farm studies in Kiambu (Sam Njihia and David Miano) 1205-1230
      • The context (RRA/longitudinal) impact of maize stem borer (SN)
      • Farmer participatory studies
      • Results to date
      • Work still needed
8. The impact of livestock on maize head smut disease and weed seed transmission - Spore and seed transmission to subsequent crops after feeding & composting. (Jackson Njuguna and Jedidah Maina) 1230-1245

9. Forage conservation. (David Miano & Joseph Methu/Land o’Lakes) 1245-1300

Lunch break 1300-1400

10. Summary
    The main messages of technologies (Alistair Murdoch) 1400-1410
    Economic implications for farmers (Peter Dorward) 1410-1415

Session C. Dissemination and training

11. Dissemination and training activities (Francis Musembi/Grace Mbure) 1415-1430
    • Farmer field days
    • Farmer exchange visits
    • Participatory on-farm research
    • Training of extension workers
    • Publications/project website/project leaflets

12. Encouraging wider dissemination
    12.1. Group discussion led by David Maino 1430-1500
        • What are the key activities and issues for encouraging uptake?
        • What could you or your organisation do to encourage uptake? (Note you may wish to concentrate on one technology)
        • Are there any other issues that need to be taken into account?

Refreshment break 1500-1530

12.2. Feedback from discussion groups representing, for example, 1530-1615
    • Extension
    • NGOs
    • Companies
    • Research organisations

13. Proposed ongoing dissemination in 2004 by R7955 team (Peter Dorward) 1615-1625

14. Concluding remarks 1625-1630

Disclaimer: This meeting is organised by 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.

Website: http://www.apd.rdg.ac.uk/Agriculture/Research/CropScience/Projects/IntegratedWeed/index.htm