Maize for food and forage in East Africa

RIU

Validated RNRRS Output.

Now, there's a basket of proven ways for farmers to meet both food and forage needs. Farmers in densely populated regions of Kenya need dual-purpose maize. They want maize that is good to eat but that also has lots of stem and leaf for animal feed. Previously, the focus was on raising grain yields in maize. Pests and diseases that affected maize foliage, and thus animal feed, were ignored. Small farmers in Kenya, Tanzania, Rwanda, Uganda and Ethiopia now use new techniques that work best for them. Some opt for maize varieties that are resistant to maize streak virus or stem borers. Others grow a fodder legume that repels stem borers. These and other techniques mean more and better animal feed in the dry season.

Project Ref: **CPP51:**

Topic: **2. Better Lives for Livestock Keepers: Improved Livestock & Fodder**

Lead Organisation: **University of Reading, UK**

Source: **Crop Protection Programme**

Document Contents:

Description

CPP51

A. Description of the research output(s)

Research into Use
NR International
Park House
Bradbourne Lane
Aylesford
Kent
ME20 6SN
UK

Geographical regions included:

Kenya,

Target Audiences for this content:

Crop farmers,

1. Working title of output or cluster of outputs.
In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.

Improving seasonal availability of forage by better IPM strategies especially of maize (R7955 IPM of maize forage dairying)

2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.

Jointly funded by Livestock Production and Crop Protection Programmes

3. Provide relevant R numbers (and/or programme development/dissemination reference numbers covering supporting research) along with the institutional partners (with individual contact persons (if appropriate)) involved in the project activities. As with the question above, this is primarily to allow for the legacy of the RNRRS to be acknowledged during the RIUP activities.

R7955

Institutional partners and personnel are listed in Appendix 1

4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? ***(max. 400 words)****.*
This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.

Problem:
Quantity and quality of forage constrains **milk** and **meat** production in the dry seasons by **small-scale livestock farmers**, many of whom are poor, in **Kenya**, **Tanzania**, **Rwanda**. **Uganda** and **Ethiopia**. Poor farmers in Kenya and **India** highlighted access to forage and water as the main constraints on **sustainable livestock production** **[i]**
. Growing **maize** (and sorghum) for food *and forage* is, therefore, important for resource-poor farmers. Impacts of weeds, pests and diseases on forage from maize has, however, generally been ignored in **sub-Saharan Africa**: crop scientists focus on grain yields and maize varieties are approved in Kenya on the basis of grain. Project R7955 investigated whether IPM strategies could increase yields of forage in the wet season with a view to conserving the excess to alleviate **dry season forage shortages**. **Training** of promotion partners in dual purpose cropping was also lacking.

Outputs:
A. **IPM strategies** for ***maize streak virus disease,***, **weeds** and **maize stem borer** to maintain **forage** and **grain yields and forage quality** of **dual purpose maize** crops
B. Adapting the **Push-Pull** system for stem borers, incorporating **head smut** resistant **Napier** and using vines to establish ***Desmodium***
C. Evaluating **forage conservation** to alleviate **dry season forage shortages**.

D. **Tools** and contracted publications
   a. ***Participatory evaluation*** *of maize varieties for food and forage – a checklist*
   b. ***Key Criteria for Policy Makers*** *on the Breeding and Dissemination of Maize Varieties for Small-scale Farmers in East Africa*
   c. ***Participatory Budgets*** *- A multipurpose tool*
   d. *Implications and lessons learned* (ref. vi)

E. Flexible process for widespread dissemination of the above and other relevant technologies to small-holder maize-dairy farmers was developed. The process involves
   a. Identifying promotion partners (government, extension, NGOs) actively working with pre-existing farmer groups
   b. **Training promotion partners** (pps) in a basket of technologies and **participatory dissemination methods**, providing technical leaflets/handouts to trainees
   c. Facilitating pps develop action plans for dissemination of selected technologies which they consider most relevant to their farmer groups
   d. Pps implementing action plans allowing farmer groups to choose technology(ies) to test on one or more of their own farms
   e. Project staff providing ongoing support to pps including leaflets, visits, telephone advice, seeds for demonstration trials, seeds and other planting materials for local multiplication and facilitating farmer-to-farmer exchange visits
   f. Pps, specialists and project staff meeting after each growing season to review progress, share experiences and lessons learned. Providing supplementary training at these meetings.

[398 words]

5. What is the type of output(s) being described here?
Please tick one or more of the following options.

Product	***Technology***	***Service***	***Process or Methodology***	***Policy***	***Other Please specify***
	X		X		

6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment

Livestock – milk – maize – forage (crop residues, thinnings, Napier, *Desmodium*)

Principles of IPM could be applied to dual purpose sorghum in drier areas.

Process output (E) has general application to dissemination of a wide range of technologies to small-holder farmers.

7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options. Leave blank if not applicable

Semi-Arid	***High potential***	***Hillsides***	***Forest-Agriculture***	***Peri-urban***	***Land water***	***Tropical moist forest***	***Cross-cutting***
X	X	X		X			

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).
Leave blank if not applicable

Smallholder rainfed humid	***Irrigated***	***Wetland rice based***	***Smallholder rainfed highland***	***Smallholder rainfed dry/cold***	***Dualistic***	***Coastal artisanal fishing***
			X	X		
				Lari (frost prone) Ndeiya (dry)		

*9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (**max. 300 words**).*

Crop protection and soil fertility outputs designed to increase grain yields, should increase forage from maize, and so help to alleviate seasonal shortages.

The dissemination phase of R7955 offered a basket of outputs which already included outputs of other projects (RNRRS and non-RNRRS). These included:

- Land O'Lakes: small-scale forage conservation using polythene tube silage.
- KARI Napier plant breeding programmes: head smut resistant cultivar, Kakamega 1, was promoted. The improved cv. Kakamega 2 would be promoted in RIU.
- KARI (Rockefeller Foundation): Coordinated Ecosystem Breeding of *maize streak virus* disease (MSVD) resistant maize cultivars. At start of project, no commercially available hybrid maize varieties in Kenya were resistant to MSVD. Cultivar KH521 was evaluated, promoted and adopted widely through R7955. In RIU, the latest varieties would be promoted.

CIMMYT: RIU could offer new MSVD tolerant open pollinated cultivars and also CIMMYT's newer "double top cross" hybrids. Cultivars with erect leaves and stay green characteristics preferred for dual purpose use.

CIMMYT/ILRI GTZ-funded dual purpose maize project: "Improving the value of maize as livestock feed"

Smallholder Dairy Project (ILRI/DFID/MoA in Kenya): Seasonal feeding strategy for SMD (concentrate reallocation). Maize – research outputs on dense planting and removing thinnings for livestock.

DFID NARP2 crop protection programme in Kenya – crop architecture with intercropping of maize and beans to reduce weeds (Chui); Napier head smut (Farrell); Intercropping Napier and Desmodium (for farms where stem borer is not a problem (Mwangi); Leaf stripping maize for forage (Abate)

R7405 Improved weed control technologies

R6642 Leaflet on MSVD and R7429 – Production of MSVD resistant OPV maize seed
[259 words]

Please specify what other outputs your output(s) could be clustered. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.

NB. The first pair apply to all maize growers and the second pair also apply in non-dairying areas but, if applicable to the farming system, they should be added to the basket of technologies being offered to promotion partners and farmers.

R8453/R7566 Grey Leaf Spot (GLS): where GLS is a problem for maize dairy farmers
R8219 Improved access to appropriate farm inputs (Links as for R7955)

R6619 Box baling (add to basket of options as an alternative and/or in addition to silage e.g. especially where *Desmodium*/Napier hay is produced)
R5188 Improving quality of cereal stover and straw (add to basket of options for more effective use of crop residues especially where IPM strategies lead to more being produced)

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[i] Heffernan C. *et al.* (2005) Livestock development and poverty. In Owen, E., Kitalyi, A., Jayasuriya, N. and Smith, T. (eds), Livestock and Wealth Creation. Improving the husbandry of animals kept by resource-poor people in developing countries. Nottingham University Press and DFID-LPP

Validation

B. Validation of the research output(s)

*10. **How** were the output(s) validated and **who** validated them?*

*Please provide brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, to which social group, gender, income category the validation was applied and any increases in productivity observed during validation **(max. 500 words)**.*

Output A:
MSVD cultivars; weed control
a) Replicated statistically validated and analysed field experiments over several seasons and in different locations. Validated by researchers and academic examiners (PhD and MSc theses) with participatory evaluation

by end users (farmers and farmer groups).

Productivity: the MSVD resistant cultivar KH 521 resulted in extra yields of 1.6 t/ha and 2.5 t/ha of thinnings and stover respectively in the short rains season (SRS) 2001 compared to the susceptible cultivar H511. Cultivar PAN 67 resulted in 1.16 t/ha of extra stover compared to H511 in SRS 2002. Resistant cultivars prevented forage and grain yield losses due to MSVD when infection occurs early in crop growth (refs vii and viii).

b) On-farm participatory multi-locational maize variety trials were carried out and evaluated by end-users – small-scale mixed gender and female farmer groups - and NGO/extension-run demonstrations. Where MSVD was a problem, output was validated.

Participatory replicated tasting trials were carried out by researchers with farmer groups (mostly female) to assess suitability for local human consumption of grain from MSVD resistant maize cultivars. New varieties were more acceptable for some uses and less for others. (ref [i]).

Outputs A&B Push-pull

Validation by participatory farmer-managed trials. Farmer groups mostly mixed gender though one female only. Poverty level: varied; Adoption and adaptation of technologies depending on incidence of stem borers. Independent validation by Farm Africa Stemborer Control project (managed by Mr Samuel Njihia of R7955) over 4 seasons, mixed gender); and by ICIPE elsewhere in East Africa.

Informal assessments during preparation of this pro forma (Oct 2006). Head of one farmer group visited. Three quarters of members of group (18/24 farmers) were growing maize cv. KH521. Several growing *Desmodium* in adaptation of push-pull. Desmodium increased milk yield by 1.5 litres per day and substituted for dairy meal concentrate. Another farmer gave a similar report. Some in drier agroecozones had discontinued push-pull due to poor drought resistance of Desmodium.

Output C Forage conservation

Economic validation of small-scale tube silage by researchers within R7955 (ref [ii]) with mixed gender farmer group who provided the figures for validation by participatory partial budgeting. Land O'Lakes analysed extra feed not otherwise available for quality and calculated extra milk output. Further adaptation of technology is needed.

Using yield increases in output A, the extra thinnings and stover in SRS 2001 from the MSVD resistant cultivar could supply maintenance energy requirement of a 350 kg cow in central Kenya for 250 and 251 days respectively[viii]. The extra stover in SRS 2002 could maintain the same cow for 181 days[viii]. These figures demonstrate the principle of alleviating seasonal forage shortages but crop residues are low quality forage and hence the importance of also conserving higher quality forage (e.g. silage).

Outputs A-E Validation by promotion partners (extension service and NGOs – Farm Input Promotions Kenya, Kenya Institute of Organic Farming) – demonstration variety trials with MSVD resistant cultivars, push pull plots. Usually conducted on farm with pre-existing farmer groups. See ref [iii]

[500 words]

*11. **Where and when** have the output(s) been validated?*

*Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above **(max 300 words)**.*

Central Highlands of Kenya. Outputs are being/have been validated in the following districts: Kiambu from 2001-2006, and from 2004-2006 in Muranga, Maragua, Kirinyaga, Nakuru.

Target beneficiaries: Resource-poor small-scale livestock producers and non-livestock keepers supplying forage to the same in high potential/peri-urban/hillside crop/livestock systems in central and other regions of Kenya where overcrowding and/or poverty are problems. The study was sensitive to the gender of farmers (many maize/dairy households are female-headed) and, where identified, the needs of landless female livestock farmers and other beneficiaries.

Production systems: high potential; hillsides; peri-urban

Farming systems: smallholder rainfed highland; smallholder rainfed (dry – Ndeiya Division; frost prone – Lari Division)

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[i][MURDOCH, A., OWEN, E. AND DORWARD, P.T. (2004). Strategies for feeding smallholder dairy cattle in intensive maize forage production systems and implications for integrated pest management. (DFID/NRIL Project R7955/ZC0180, Final Technical Report. 71 pp including appendices. Available online (two files):
http://www.apd.rdg.ac.uk/Agriculture/Research/CropScience/Projects/IntegratedWeed/Final%20technical%20report%20for%20Project%20R7955.doc
http://www.apd.rdg.ac.uk/Agriculture/Research/CropScience/Projects/IntegratedWeed/Final%20technical%20report%20for%20Project%20R7955%20-%20appendices.pdf

[ii] MURDOCH, A., NJUGUNA, J, AND OWEN, E. (2004) Report on Stakeholder Meeting, 2 April 2004. Strategies for feeding smallholder dairy cattle in intensive maize forage production systems and implications for integrated pest management. (DFID/NRIL Project R7955/ZC0180). Available online:
http://www.apd.rdg.ac.uk/Agriculture/Research/CropScience/Projects/IntegratedWeed/Stakeholder%20Meeting%202%20april%202004%20report.pdf

[iii] KIBATA, G.N., MWENDIA, S., MURDOCH, A.J., NJUGUNA, J.G.M. 2006. Report on Final Promotion Partners' Workshop, Kamweti Farmers Training Centre, Kirinyaga, Kenya, 30 November to 2 December 2005. KARI-NARC-Muguga, Kenya and Dept. of Agriculture, University of Reading, U.K.

Current Situation

C. Current situation

12. ***How and by whom*** *are the outputs currently being used? Please give a brief description* ***(max. 250 words)****.*

Farmers in different places are selecting parts of technologies which are appropriate to them. In many places technologies are adopted in entirety. MSVD resistant maize cultivars have not replaced susceptible cultivars in entirety. MSVD does not reach epidemic proportions every year and so farmers are growing >1 variety as some characteristics of the old varieties and landraces are still preferred.

With more complex technologies such as push-pull, adaptations and partial adoptions have occurred in Central Kenya where maize stem borers are not a serious problem. Farmers have adopted Desmodium as a forage in a variety of ways and many have adopted the Napier head smut resistant cultivar, Kakamega 1. Some are intercropping Napier and Desmodium which nullifies stem borer control but the mixture (75%:25%) highly valued for forage and ensiling. Others are growing Desmodium as ground cover for forage and weed suppression underneath fruit trees. They observe their milk yields increase as soon as they start feeding *Desmodium*!. Desmodium is, however, only suitable in higher rainfall areas.

13. ***Where*** *are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used* ***(max. 250 words).***

Central Highlands of Kenya (districts: Kiambu, Muranga, Maragua, Kirinyaga and Nakuru) Agroecozones: Upper Midlands 2-3; Lower Highlands 1-2; but not in Lower Highlands 3,4 due to drought
Full details provided in ref. iv.
Push-pull is disseminated more widely in East Africa by ICIPE and Farm Africa and tube silage by Land O'Lakes.

14. What is the scale of current use? Indicating how quickly use was established and whether usage is still spreading ***(max 250 words).***

Significant dissemination commenced in early 2004 and promotion partners had been trained following the process in output (E) by November 2004. At a review day with promotion partners in December 2005, they estimated that at that early stage, 190, 15 and 498 farmers had adopted 'push-pull', tube silage and MSVD resistant cultivars, respectively.

Usage and dissemination continued in 2006. For example, by October 2006, 550 farmers are estimated to have adopted push-pull in Central Kenya – many through an independent Farm Africa project which arose from R7955. When visited on 5th October 2006, the chairman of Karweti Farmer Group indicated 18/24 farmers in the group were growing MSVD resistant maize and he had given Desmodium vines to others

Napier head smut resistant cv Kakamega 1. Distributed from KARI Muguga to 1300 individual farmers; focal points – FTCs Waruhiu, Wambugu, Muranga Inst of Science and Technology (800-1000 farmers some taking pick-up loads); Kamweti. Each farmer tends to give to 3-4 others. R7955 promotion partner, FTC Kamweti, sold 3000 canes and gave Desmodium free over about 12 months to October 2006. Perhaps 100000 small-scale dairy farmers in Kenya are now reckoned to be using this variety.

[192 words]

*15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key facts of success? **(max 350 words).***

Effective **researcher-extension/NGO-enduser linkages** and engagement were achieved via output (E) of R7955 allowing simultaneous training of Front Line Extension Workers and their managers in technologies. Linkage provided ongoing support where needed and rapid feedback of problems. Linkages ensured that seeds for demonstration trials and nurseries (Desmodium) and canes (Napier) were easily transferred for demonstrations by extension/NGOs and evaluation by farmers and farmer groups.

Government funding of extension workers and farmer training centres. Funding was adequate for us to piggy-back our outputs on to their existing outreach to pre-existing farmer groups at minimal marginal cost. In this connections, working with pre-existing Community-Based Organisations (farmer groups) is believed to be vital as the CBOs then have a raison d'etre other than a our dissemination programme.

Partnerships with NGOs willing to disseminate technologies developed in project.

Liberalisation of seed market in 2003, removing monopoly by Kenya Seed Company and opening way to promotion of MSVD resistant cultivars. Liberalisation has meant that MSVD resistant cultivars are more widely available via RNRRS project R8480.

Seed companies participated in stakeholder meetings and field days. Freshco, who were marketing KH521, were asked to ensure the cultivar was available in areas where dissemination was occurring.

Availability of a large **market for meat and milk** through both the informal and formal sector. The latter is via the public sector, Kenya Cooperative Creameries and other private sector companies.

Multi-disciplinarity of project team provided a platform for capacity building, within and across disciplines and within and between institutions. The demand led, pro-poor focus and the cross-disciplinary aim of the project – improving livelihoods of small-scale farmers by alleviating seasonal forage shortages through better crop protection – enabled and necessitated a hybridization of ideas from different disciplines.

Capacity building provided an incentive to team members: two members of the Project Team gained higher degrees. Others co-authored and presented conference papers outside Africa. Good intra-team e-mail communication and attendance at many stakeholder meetings, field days and training/dissemination workshops
[323 words]

Current Promotion

D. Current promotion/uptake pathways

*16. **Where** is promotion currently taking place? Please indicate for each country specified detail what promotion is taking place, by whom and indicate the scale of current promotion **(max 200 words).***

Central Highlands of Kenya
By December 2005, about one year after training, promotion partners had reached 31 farmer groups (351 men and 374 women farmers). They had also held 11 field days attended by over 4100 farmers.

Information gathered during preparation of this proforma indicated on going dissemination. A Field Day at FTC Waruhiu on July 7th 2006, was attended by over 4000 farmers over 1000 of whom visited the demonstration on MSVD resistant cultivars and took the project leaflet on "*More forage from maize*" (ref v). [A previous field day had been organised there by project R7955 in early 2004.] Promotion partner Kamweti FTC also held a field day on 24 February 2006 attended by 1033 farmers and about 400 visited this promotion partner's combined plot demonstrating push-pull and MSVD resistant cultivars. As a result of R7955, this promotion partner sells canes of Napier head smut resistant cv Kakamega 1 and gives free Desmodium vines to the purchasers. Around 3000 were sold over the last 12 months. It is reckoned each person acquiring Napier distributes canes to 3-4 other farmers. It is estimated 100000 out of 650000 small-scale dairy farmers in Kenya may now be growing Kakamega 1.
[199 words]

*17. What are the current barriers preventing or slowing the adoption of the output(s)? Cover here institutional issues, those relating to policy, marketing, infrastructure, social exclusion etc. **(max 200 words)**.*

1. Linkages enabling research and front line extension workers and their managers to engage with each other and with endusers. R7955 facilitated this linkage via Output E and validated its value in dissemination.
2. Farmer Field School facilitators need to be trained and have access to demonstration plots. Because of mobility of staff, key people should train others who could be permanent local facilitators e.g. heads of farmer groups.
3. General lack of on-the-job training in new technologies and participatory dissemination methods by government, NGOs.
4. Inadequate resourcing of extension services to disseminate new technologies using participatory planning and participatory budgets where appropriate. Personnel must work in areas for sufficient periods, because technologies like push-pull require more than one season to demonstrate.
5. Slow release of new cultivars - good links needed between breeders and seed companies.
6. Plant variety rights organisation in Kenya does not recognise need for dual purpose crops
7. Tube silage needs down-scaling from 500kg batches
8. Availability of Desmodium seeds and knowledge. Desmodium seeds cannot be sold in Kenya through seed merchants as no seed production is currently certified
9. Risks of disease/weed transfer e.g. Napier stunt disease, when moving planting materials.

[198 words]

*18. What changes are needed to remove/reduce these barriers to adoption? This section could be used to identify perceived capacity related issues **(max 200 words).***

1. Developing bidirectional research-extension-enduser linkages via, for example, process outlined in output E
2. Training of trainers in technologies and participatory dissemination methods.
3. As 2
4. Inform those in charge of extension services and NGOs of benefits and costs of using participatory planning and budgets to disseminate new technologies where appropriate. Also inform managers at top level of timescale needed for disseminating technologies like push-pull.
5. Seek for rapid release of promising new cultivars and pre-release for evaluation.
6. Distribute outputs D(a) and D(b) to relevant policy makers
7. Work with R6619 and Land O'Lakes to down-scale tube silage.
8. Encourage seed companies to produce/import certified Desmodium seed
9. Raise awareness in training of biosecurity (weeds and diseases) when moving planting materials and manure.

Generally raise awareness of technologies through mass media and local radio stations.
[144 words]

19. What lessons have you learnt about the best ways to get the outputs used by the largest number of poor people? ***(max 300 words).***

Study commissioned to investigate implications and lessons learned from the project (ref [i])

The dissemination process output (E) in section 4 above was highly effective at low cost.

Linking with other effective disseminators (Farm Input Promotions; Kenya Institute of Organic Farming and extensionists) and through them to pre-existing Community-based organisations, enabled very cost-effective adoption for project R7955.

Key elements were

- the wide appeal of the subject matter to smallholders and other stakeholders, with its emphasis on pest management of maize for forage and food and alleviation of seasonal forage shortages;
- ability to demonstrate that technologies could enhance livelihoods;
- offering a basket of technology options; promotion partners selected outputs for local dissemination and farmers selected according to need.

Participatory research helped keep the stakeholders engaged. A combination of on-station and on-farm participatory research were used in order to ensure robustness of hypothesis testing, appropriate adaptation and a high interest in adoption.

Understanding local farming systems in facilitating innovation.

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[i] OWEN, E., LUKUYU, B.A., MURDOCH, A.J., MWANGI, D.M., NJUGUNA, J.G.M. and DORWARD, P.T. 2006. Implications and lessons learned for stakeholders from DFID Project R7955: IPM of Maize Forage Dairying. KARI, Kenya and The University of Reading, Reading, UK. 40 pp. Available online: http://www.apd.rdg.ac.uk/Agriculture/Research/CropScience/

Projects/IntegratedWeed/
Implications%20and%20lessons%20learned%20for%20stakeholders.pdf

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Impacts On Poverty

E. Impacts on poverty to date

20. Where have impact studies on poverty in relation to this output or cluster of outputs taken place? This should include any formal poverty impact studies (and it is appreciated that these will not be commonplace) and any less formal studies including any poverty mapping-type or monitoring work which allow for some analysis on impact on poverty to be made. Details of any cost-benefit analyses may also be detailed at this point. Please list studies here.

The project completed its exit strategy in March 2006. Funding for the final phases of the project was extremely limited (£36000 over two years) and allowed for training and support of a very limited number (20) of promotion partners. No formal impact studies were funded, but economic analyses were carried out using figures provided by farmer groups and in some cases as a participatory process with them of the costs and benefits of using resistant cultivars for control of maize streak virus disease (Compare refs [i] and [ii]), push-pull for maize stem borers in combination with conserving excess forage for use in the dry season, and of different weed control strategies.

21. Based on the evidence in the studies listed above, for each country detail how the poor have benefited from the application and/or adoption of the output(s) ***(max. 500 words):***

- *What positive impacts on livelihoods have been recorded and over what time period have these impacts been observed? These impacts should be recorded against the capital assets (human, social, natural, physical and, financial) of the livelihoods framework;*
- *For whom i.e. which type of person (gender, poverty group (see glossary for definitions) has there been a positive impact;*
- *Indicate the number of people who have realised a positive impact on their livelihood;*
- *Using whatever appropriate indicator was used detail what was the average percentage increase recorded*

Maize streak virus disease control (very widely adopted often on a field-to-field basis in areas prone to disease). Use of resistant cultivars prevented statistically significant reductions in gross margins (including all grain, forage and bean intercrop outputs and input costs). Reductions in gross margins (GM) with commonly grown susceptible cultivar could be 37.5% compared to the GM of an uninfected crop. In high potential areas where plot sizes are small, this could amount to a loss in economic output equivalent to US$60 in a typical maize plot of approx. 0.1 ha. (Compare refs [iii] and [iv]).

Push-pull economic analysis (adopted by 550 farmers in Central Kenya since about 2004.) Economically, the labour costs of setting up the push-pull plots was high, but financial benefits improved as the trial progressed into the second season. Ensiling the forage produced from the push-pull system (labour and materials cost KSh 3725 for 3 tonnes of silage) and costing the value of the resultant milk output during dry seasons, made the push-pull system profitable during the dry seasons assumed to include January-March and August and September each year. A milk output of 8 l d^{-1} over the assumed five months dry season per year was valued at KSh 19328. The gross margin over the cost of producing the silage was therefore KSh 15603. By comparison, the gross margin without conservation was still negative (KSh •972) if the high cost of buying in grass from the coffee estates was included. The impacts of the push-pull system in combination with forage conservation on the livelihoods was therefore shown to be highly favourable. (Compare refs [v] and [vi]). Informal enquiries while preparing this pro forma indicated that forage supplementation by Desmodium could replace dairy meal feed supplements and increased milk yields by 1-1.5 litres per cow per day (e.g. from 3.5 to 5 litres/day).

It is, therefore, clear that acquisition of livestock linked with forage conservation to enhance milk production in dry seasons is a potential route out of poverty for target endusers of technologies. Equally without livestock and forage conservation, there is very little return on labour inputs.

This inference is supported by other studies by Land O'Lakes on forage conservation and by ICIPE on push-pull.

Other studies of technologies developed in other projects but included in the "basket" promoted in output (E). Improved dry season feeding strategies using conserved hay and crop residues have increased milk production from 7.5 to 12 litres of milk per cow per day for farmers surveyed in the southern highlands of Tanzania[vii]. Incomes of 92% of farmers increased from 276000 to 459000 Tanzanian Shillings per year (224 to 373 US$).

The above has emphasised financial capital. Other livelihood impacts include:

Human capital: both men and women farmers were desperate for information on new technologies and gained skills in adapting them to their farms; they could understand potential benefits after participatory budgets were prepared. (The process output (E) was developed with two farmer groups – one all female, the other mixed gender. Alleviation of forage shortages in dry season leading to more milk has benefits to human nutrition and health and prevention of malnutrition; the increased income will allow farmers to pay school fees for their children (cf.[xxiv]);
Social capital: use of pre-existing farmer groups, training in establishing Desmodium nurseries and facilitating farmer-farmer exchange visits facilitated transfers of planting materials (Napier, Desmodium) and greater connectedness between households;
Natural capital: soil fertility is improved by *Desmodium* and also because feeding more and better quality forage leads to more manure. Desmodium and Napier are both effective for reducing erosion on hillsides.
Physical capital: increased financial capital gives improved ability to pay for communication, transport, shelter and production equipment.

The majority of farmers are moderately poor, some extremely poor, with some extreme dependent poor and malnourished children.

[i]

LUKUYU, B.A., MURDOCH, A.J., McLEOD, A., DORWARD, P.T. (2004) The impact of *maize streak virus* disease on quality and yield of maize forage outputs of the maize-dairy production systems in central highlands of Kenya. Proceedings Livestock Development Studies Group Conference *on* Focus on Livelihoods, 16 October 2004 , University of Reading, 6 pp. Available online http://www.livestockdevelopment.org/Paper%5CFull%20paper%20Ben%20October%202004.pdf

[ii]

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Environmental Impact

H. Environmental impact

24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)? ***(max 300 words)***

This could include direct benefits from the application of the technology or policy action with local governments or multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate evidence can be provided in the form of an annex.

Improved productivity of livestock systems, produces benefits in concomitant increases in manure, which, if utilised in turn reduces fertiliser needs and provides more grain and forage for the next season – a virtuous circle.

Forage legumes like *Desmodium* fix atmospheric nitrogen and suppress growth of weeds.

Alleviation of poverty is obviously linked to economic growth, but it also gives opportunities and extra resources to avoid overexploiting natural resources and loss of biodiversity.

25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)? ***(max 100 words)***

Intensive dairy systems have adverse impacts in terms of methane production (greenhouse gas) and slurry must be handled with care in urban/peri-urban areas.
The problems of industrial scale livestock production in urban areas are well-known but do not apply to small-scale farmers who can recycle nutrients back to the soil.

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience? ***(max 200 words)***

Conserving excess forage from the wet season for use in dry season, not only helps to alleviate dry season forage shortages but also those shortages which occur when dry seasons become droughts. Ensuring that crop residues are stored appropriately to prevent losses to termites etc. is also a good insurance against drought since the residues can meet maintenance energy requirements for complete dry seasons (see section 10). Natural disasters include pest and disease epidemics on crops. IPM strategies, by definition, reduce the risk of crop failure and increase resilience. Forage conservation also reduces the time and energy farmers must spend looking for forage in the dry season (see section 22).

Annex

APPENDIX 1 Institutional Partners and Personnel in Project R7955

Organisation	Name	Specialist Discipline	Notes
The University of Reading	Dr Alistair Murdoch	Joint Project Leader, Weed Scientist/Crop Scientist	2001/6
	Prof Emyr Owen	Joint Project Leader, Animal and Forage Scientist	2001/6
	Dr Peter Dorward	Socio-economist and joint project leader (2004/6)	2003/6
	Dr Ahmed Jama	Plant Pathologist	2001/4
	Dr Fergus Mould	Forage Quality Specialist	2001/4
	Dr Simon Gowen	Plant Pathologist	2001/4
KARI-Muguga	Dr Jackson Njuguna	In-country Co-ordinator, Plant Pathologist	2001/6
	Dr David Miano Mwangi	Animal and Forage Scientist	2001/6 Latterly at KARI HQ
	Mr Samuel Njihia	Entomologist	2002/6
	Mr Frances Musembi	Socio-economist	2001/4
	Mrs Grace N. Mbure	Anthropologist, Gender Advisor	2003/6
KARI-Muguga, ILRI, Reading University	Dr Ben Lukuyu	Animal and Forage Scientist; PhD student	2001/6 ILRI Graduate Research Fellow
KARI-Muguga, KARI-NARL, Nairobi University	Mr Benjamin M. Kivuva	MSc Crop Science student – weed science	2002/4
KARI-NARL Kabete	Dr Jedidah M. Maina	Weed Scientist	2001/6
	Mr Gilbert Kibata	Entomologist	2005/6
KARI-EMBU	John Muthamia	Weed Scientist	2002/4
ILRI, Nairobi	Dr Dannie Romney	Animal Nutritionist	2001/6
PAN Livestock Services, Reading, UK.	Dr Anni McLeod	Socio-economist	2001/3
Kenya Institute of Organic Farming	Mr John Njoroge	Dissemination/farmer training	2002-

Land O'Lakes	Dr Joseph Methu	Dissemination/training: tube silage	2002-