RIU

Better planning for tsetse control

Validated RNRRS Output.

A user-friendly decision-support tool called ‘Tsetse Muse’ is now available to help users better plan and budget when using the many different methods of tsetse fly control available. Tsetse flies affect 10 million square kilometres in tropical Africa, where they transmit the trypanosomes that cause sleeping sickness in humans and nagana in livestock. Plus, the flies can easily travel large distances. This means that tsetse controls are very difficult to plan, as they have to be applied over very large areas at once—often in combination. The ‘Tsetse Muse’ computer programme can help these efforts in a number of ways, and is already being applied in Botswana, Uganda, Mozambique and Zimbabwe. Uses include assessing the impact and cost effectiveness of techniques like aerial spraying.

Project Ref: **AHP15:**
Topic: **2. Better Lives for Livestock Keepers: Improved Livestock & Fodder**
Lead Organisation: **Natural Resources Institute (NRI), UK**
Source: **Animal Health Programme**

Document Contents:

Description

AHP15

Research into Use
NR International
Park House
Bradbourne Lane
Aylesford
Kent
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Geographical regions included:

Botswana, Mozambique, Uganda, Zimbabwe,

Target Audiences for this content:

Livestock farmers,

A. Description of the research output(s)

1. Working title of output or cluster of outputs.

Tsetse muse, an interactive computer programme designed to help planners develop cost-effective strategies for controlling tsetse

Alternative long title:-

Tsetse muse, an interactive computer programme to assist in the design and analysis of area-wide interventions against tsetse

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

The research projects that contributed to the development of this output were supported by: DFID's Animal Health (AHP) and Livestock Production (LPP) programmes, the EU-supported Farming in Tsetse-Controlled Areas (FITCA) project and the Zimbabwe Department of Veterinary Services.

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.

Funding agency	***Project no.***	***Project title***
AHP	R7987	Message in a bottle: disseminating tsetse control technologies.
LPP	R8459	Tsetse muse: an interactive programme to assess the impact of control operations on tsetse populations.
AHP	(Prog. Dev.)	Tsetse eradication: sufficiency, necessity and desirability

Project Partners (contact person):

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FITCA-Tanga: Capricorn Consultants Ltd, Tanga, Tanzania

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*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.*

Tsetse occupy 10 million km^2 of tropical **Africa** where they transmit **trypanosomes** causing s**leeping sickness** in humans and **nagana** in livestock. Each year these diseases cost the **rural poor** ~1.6 million **disability-adjusted life years** (**DALY**s) and produce livestock production losses of ~US$4.5 billion. Drugs to relieve both diseases exist but **drug resistance** is widespread and vaccines are unlikely to become available soon, if ever. Hence, the only safe and reliable way of eliminating African trypanosomiases is by controlling tsetse.

The many effective methods of tsetse control differ grossly in cost and complexity, and hence their suitability for poor countries. At one extreme is the expensive and technically demanding **Sterile Insect Technique** (**SIT**) involving the release of **sterile males**. At the other end is the cheaper and simpler use of **insecticide-treated cattle** (**ITC**). In between are various spraying measures which spread insecticide widely, as in **aerial spraying**, or apply it to **artificial baits** (eg, **odour-baited targets**).

Unfortunately, all methods of tsetse control are difficult to plan. For example, tsetse are highly mobile so they must be tackled over wide areas, not by one farmer alone. Some methods, such as aerial spraying, are suitable for the first attack; others such as insecticide-treated cattle and artificial baits are also useful to clear residual infestations and prevent **re-invasion**. Moreover, the timing and impact of different methods varies, making **integrated control** difficult – but not impossible.

In 2005, the **decision-support tool** '**Tsetse Muse**' was developed to assist the understanding, planning and budgeting of all methods of tsetse control, employed singly or together, sequentially or simultaneously, in the same area or adjacent blocks, and in homogeneous or varied habitats. The programme has been used to examine matters such as a general comparison between SIT and ITC, the impact of aerial spraying in **Botswana** and the cost-effectiveness of various techniques in **Uganda**.

The African Union's Pan-African Tsetse and Trypanosomiasis Eradication Programme (**PATTEC**) has initiated **area-wide** operations to eliminate tsetse in **Angola**, **Botswana**, **Burkina Faso**, **Ethiopia**, **Ghana**, **Kenya**, **Mali**, **Uganda** and **Zambia**. These operations will use various methods including SIT, ITC, aerial spraying and artificial baits. Smaller-scale operations to control tsetse are also being promoted by **NGO**s and government organisations in many countries. The widespread use of 'Tsetse Muse' will assist in the successful integration of these methods and operations, and provide a framework for assessing their cost-effectiveness.

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	X	Decision support tool

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

The better understanding, planning and budgeting of tsetse control will improve the health of cattle, other livestock and humans, at lower cost and greater speed.

Improvements in the health and productivity of draught animals – particularly cattle – will benefit mixed crop-livestock systems. For example, the absence of draught animals in tsetse-affected areas of Ethiopia causes delayed planting, low yields and high costs of producing maize, cotton and sorghum.

Research by AHP-supported projects shows that the use of insecticide-treated cattle could also be refined to deal simultaneously with malaria in southern Africa, the Maasai steppe of East Africa, the Greater Horn, and the Sahel. The main vector of malaria in these places is *Anopheles arabiensis* which feeds on humans and cattle. To elucidate this means of tackling malaria, and in recognition of the benefits of the type of output produced by the present project, the South African Centre for Epidemiological Modelling and Analysis is producing a programme, called SacemaM, to help teach the dynamics of mosquito-borne diseases and to plan their control. SacemaM is copying almost all of the format and programming code of Tsetse Muse. Taken together, the two programmes could cover virtually any disease transmitted by any blood-feeding insect, and so assist the control of many diseases of livestock and humans throughout the World, so benefiting the production of numerous commodities.

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			

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	X	

*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**).*

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.

The Tsetse Plan output could be included in the following clusters.

Decisions tools to support the control of vector-borne diseases. An integrated package of decision support tools could be produced by clustering Tsetse Muse with its sister programme '**Tsetse Plan**' (AHP Output) and tools developed by non-DFID research initiatives such as **SacemaM** (a tool for modelling mosquito populations; SACEMA, South Africa) and **Mageta Model** (a tool to assess the effect of auto-sterilisation of tsetse; EU-funded FITCA).

Reducing the cost of vector control. This output is linked closely to the AHP output '**Tsetse control through restricted application of insecticide to cattle**'. Recent data and field experience with the restricted application of insecticide to cattle would add value if incorporated into Tsetse Muse.

Improving human and animal health and productivity. The present output also clusters with those concerned with controlling sleeping sickness (AHP outputs: '**Diagnostics that can identify human-infective trypanosomes in cattle blood**' and '**Treatment of cattle to eliminate the animal reservoir of *T. b. rhodesiense***').

The prompt and accurate diagnosis of the diseases affecting livestock is a prerequisite for cost-effective management and hence there are synergistic links between this output and '**Simple decision tools for diagnosis of endemic diseases in Africa**' which includes tools to improve the diagnosis and management of trypanosomiasis. Moreover, healthy livestock are an integral part of mixed farming systems in sub-Saharan Africa, especially through their contributions to draught power (CPP: **Draught animal power**; LPP: **Draught animal toolbox)**.

Capacity building. Tsetse Muse could be developed as a training resource for animal health specialists. Accordingly, this output links to the AHP outputs: '**AUVEC'** and **'Creation of a common … African veterinary network'**. More generally this output also links with those concerned with the dissemination of knowledge using electronic media (eg, LPP output: **Information kiosks in India**).

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)**.*

How. – The simulation models underpinning Tsetse Muse were based on data for the behaviour and dynamics of tsetse and on planning principles that had already been validated by their successful use in closely monitored campaigns. For example, information on the release of sterile insects came from work on Unguja Island, Zanzibar. Matters related to various spraying techniques, traps, targets and insecticide-treated cattle originated from many countries, including Burkina Faso, Ethiopia, Ivory Coast, Kenya, South Africa, Tanzania, Malawi, Zambia and Zimbabwe. This information was then generalised and built into the programme's model, with facilities to allow variation in the full range of local conditions and technical specifications. Not surprisingly, the model "predicted" the results actually achieved by the many and varied campaigns with which it was "trained".

The more critical yard-stick is the extent to which the programme can explain the failure or delayed success of other campaigns, ie, the work with which it was not trained, and how well it covers the tactics needed to put such operations right. Hence, it is encouraging that the Tsetse Muse outputs accord with the poor performance of campaigns such as sterile insect releases on mainland Africa, the use of insecticide-treated cattle over a relatively small area of Mkwaja Ranch in Tanzania, and the many seasons of aerial spraying in Botswana in the last century. The outputs also show why the increased scale of aerial spraying in Botswana, coupled with the proper use of baits, eventually solved the problem (Kgori *et al*., 2006).

Who. – Tsetse Muse was initially developed using information derived from international refereed journals and discussions with campaign managers. An account of the structure, function and application of the programme is provided by Vale & Torr (2005). Use of Tsetse Muse to analyse control operations in Botswana was undertaken by Kgori *et al*. (2006), and Shaw *et al*. (2006) used the program to compare the costs of various strategies to control tsetse in Uganda.

Proponents of SIT have challenged aspects of the program as it is applied to the use of this particular technique but none of their objections has been substantiated in peer reviewed journals. The TECA (2006) website entry for Tsetse Muse (TECA record 1926) erroneously reports that Tsetse Muse 'only allows for a constant mortality rate to be applied to the whole population' and concludes that 'Tsetse Muse is unable to predict the cost of an elimination of *G. palpalis* in West Africa since it predicts that it would be possible using sprayed cattle only, whereas field results have concluded that this is not possible without the use of SIT'. In fact, Tsetse Muse does allow the user to specify variable mortality rates (Vale & Torr, 2005) and there are no peer-reviewed data showing that the elimination of *G. palpalis* can be achieved with SIT only.

*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)**.*

The simulation models that underpin Tsetse Muse were initially validated by scientists working in Zimbabwe and the UK between 2003 and 2005.

Applications of the program to (i) assess the impact of aerial spraying operations in Botswana and (ii) compare the costs of various tsetse control interventions in Uganda were undertaken in 2005-2006 by scientists working in Botswana, Uganda, Rome (FAO) and UK.

Current Situation

C. Current situation

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

Tsetse Muse became available as a user-friendly programme only a year ago and hence its current use is limited to the following.

1. The FAO's Pro-Poor Livestock Policy Initiative (PPLPI) is using Tsetse Muse to assist the government of Uganda in the development of a rational strategy for controlling tsetse. In particular, the model is being used to provide information on the likely timing, impact and material requirements of various methods of control. These data are then incorporated into various economic models which allow the project to compare the cost and effectiveness of various interventions.

2. Scientists of the Government of Botswana have used Tsetse Muse to analyse the impact of aerial spraying operations in Ngamiland. The program was used to assess the probability that tsetse had been eliminated by aerial spraying operations conducted in 2001-02 and to explore why these operations were so much more successful than the ca. 19 operations conducted over the previous two decades (Kgori *et al*., 2006)

3. In Mozambique, Cawood Beef Ltd is using Tsetse Muse to assess the feasibility of various tsetse control measures near Tete in Mozambique.

4. The Zimbabwe Department of Veterinary Services is using Tsetse Muse as a training tool for its entomologists.

5. The University of Greenwich has continued to host the Tsetse Muse programme which, together with supporting literature, can be downloaded from the tsetse.org website (www.tsetse.org). The programme has been downloaded 86 times in 2006.

All the above users have been supported by the original authors of Tsetse Muse.

*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).***

1. Tsetse Muse is being used to support tsetse control operations in Botswana, Uganda, Mozambique and Zimbabwe as described above (Q12).

2. The programme can be downloaded from www.tsetse.org and hence is available to any users who have access to the world-wide web. CD-ROMs of the programme have also been distributed at meetings in Ethiopia, Uganda, Kenya and Zimbabwe.

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

Current use of the programme is limited to a few (<10) users associated with tsetse control projects in Botswana, Mozambique, Uganda and Zimbabwe. In general, use of Tsetse Muse is being supported by direct help from the original authors (Vale & Torr) of the programme.

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).***

The following matters are likely to influence uptake of Tsetse Muse.

1. *Institutions.* Tsetse Muse is designed for users planning area-wide operations that may include complex and expensive techniques such as aerial spraying and SIT. Such operations are likely to be within the technical and financial competence of only government or donor agencies and hence the programme should be promoted primarily to these institutions. The needs of institutions concerned with community-based interventions against tsetse are addressed by the sister programme 'Tsetse Plan' (see Tsetse Plan dossier).

2. *Personnel*. Senior managers of, say, government veterinary departments are ultimately responsible for the planning and implementation of area-wide operations to control tsetse. However, it is unrealistic to expect them to use decision tools such as Tsetse Muse; they are usually too busy with administration and their concerns are generally broader than tsetse control. In practice therefore, technical planning is usually performed by junior personnel who are familiar with technical aspects of tsetse control and the use of computers and models. Accordingly, use of Tsetse Muse is likely to be greater if the programme is promoted to the lower and middle-level scientists who advise senior managers, and who will one day be such managers themselves.

3. *Capacity strengthening*. The use of Tsetse Muse as a teaching tool suggests that uptake is likely to be greater if teaching modules based on the use of Tsetse Muse are developed in collaboration with the individuals and institutions concerned with training biologists and veterinarians. Promotion of the programme to undergraduate and postgraduate scientists will also support subsequent use of the programme by graduates who join organisations concerned with the planning of tsetse control.

4. *IT infrastructure*. As with all computer-based systems, the underlying IT infrastructure has a profound effect on the uptake of Tsetse Muse. The programme is computationally intensive and while this is not a problem for modern PCs, older (pre-2000) computers and operating systems are not suitable.

5. *Language.* Tsetse Muse is written in English and thus uptake is likely to be greater in Anglophone countries rather than those where French, Portuguese or African languages predominate.

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.

With effective land-use planning and implementation, tsetse control can alleviate environmental-degradation associated with the concentration of people and livestock into areas naturally free of tsetse.

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

Modern bait methods of tsetse control do not have any significant direct impact on the environment. Widespread application of insecticide by either aerial or ground spraying may have an impact on some non-target species but evidence from Botswana, Zambia and Zimbabwe suggests that these are slight and transient. The Sterile Insect Technique is always used in conjunction with an insecticidal technique and operations using this method may have slight and transient impacts. Without effective land-use planning and implementation, tsetse control could lead to environmental-degradation arising from inappropriate land-use.

*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)***

Predictive models of climate change suggest that there will be shifts in both (i) areas suitable for pastoral and mixed system and (ii) the distribution of tsetse (Thornton et al., 2002, 2006). Tsetse-borne trypanosomiasis will continue to be a significant problem and area-wide approaches to tsetse control will play an important role in any future scenario.

More generally, tsetse control will contribute to the health and productivity of livestock which play an important role in reducing vulnerability to natural and man-made disasters (see Q21).

Annex

References

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