RIU

Waking up to better ways of tackling sleeping sickness

Validated RNRRS Output.

New, cost-effective ways of controlling sleeping sickness in people and nagana in cattle are being applied in Uganda. These techniques involve treating infected cattle with drugs that kill blood-borne trypanosomes (which cause these diseases), and applying insecticides to the specific parts of the cattle that tsetse fly bite to feed (like the legs and belly). Conventional methods of tackling sleeping sickness concentrate on detecting and treating human cases and killing the tsetse flies that spread the disease. But, this doesn't address the fact that cattle are the major reservoir of the disease. In fact, almost 50% of the cattle living in some areas carry the disease. The new methods that have been developed offer a way of combating the problem at source.

Project Ref: **AHP02:**
Topic: **2. Better Lives for Livestock Keepers: Improved Livestock & Fodder**
Lead Organisation: **Centre for Infectious Diseases, University of Edinburgh, UK**
Source: **Animal Health Programme**

Document Contents:

Description

AHP02

Research into Use
NR International
Park House
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Geographical regions included:

Uganda,

Target Audiences for this content:

Livestock farmers,

A. Description of the research output(s)

1. Working title of output or cluster of outputs.

Control of zoonotic sleeping sickness by treatment of domestic livestock

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. Additional funding and support was provided by: World Health Organisation, EU Farming in Tsetse Controlled Areas (FITCA), The Wellcome Trust and a new public-private partnership funded by CEVA Santé Animale and Industri Kapital.

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.

Funding agency	***Project no.***	***Project title***
AHP	R7596	Decision support system for the control of trypanosomiasis in South-East Uganda: improving public health and livestock productivity through the cost-effective control of trypanosomiasis in livestock
AHP	R7360	Field methods and tools for resource poor farmers and extension workers to improve targeting and appropriate use of drugs for control of African bovine trypanosomiaisis
AHP	R7597	A low cost haemoglobinometer as a decision support tool for bovine disease diagnosis in sub Saharan Africa
AHP	R8318	Decision support for endemic disease control in sub-Saharan Africa – private sector drivers for technology adoption for resource poor farmers.
AHP/LPP	R6559	Preliminary study of the effects of host physiology on the efficacy of cattle as baits for tsetse control.
AHP	R7173	Cattle management practices in tsetse-affected areas.
AHP	R7364	Improving the control of tsetse: The use of DNA profiling to establish the feeding responses of tsetse to cattle.
LPP/AHP	R7539	Environmental risks of insecticide-treated cattle in SA livestock systems.
AHP	R7987	Message in a bottle: disseminating tsetse control technologies.

AHP	R8214	Integrated vector management: controlling malaria and trypanosomiasis with insecticide-treated cattle.
LPP	ZC0254	General model for predicting the effect of insecticide-treated cattle on tsetse populations.

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4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced?

The output is a new, **cost-effective** and **sustainable** approach to the control of **zoonotic sleeping sickness** by treatment of **cattle** with **trypanocidal drugs** and **insecticide**, developed between 2000 and 2006.

In **Uganda,** cattle have been shown to be asymptomatic carriers of ***Trypanosoma brucei rhodesiense***, which causes **acute** sleeping sickness in people. Almost 50% of cattle carry the parasite in endemic zones[1,2]

If a large enough proportion of the cattle population are treated with standard **trypanocidal drugs**, the reservoir of disease in animals can be controlled, preventing new sleeping sickness cases arising[3]. Furthermore, spraying cattle with insecticide using the '**restricted application'** technique (targeting the cattle parts where tsetse feed)[4,5] will **cost-effectively** prevent re-infection and sustain drug treatment **benefits**[3,6].

Since the beginning of the 20th century, hundreds of thousands of people have died of Rhodesian sleeping sickness in Uganda. Conventional approaches to its control consist of detecting and treating human cases and killing tsetse flies. While **case detection** and **treatment** is essential, it does little to prevent new cases arising. People are 1000-times more likely to become infected via the bite of a tsetse which has acquired the infection from cattle than from infected people[3]. Traditional **tsetse control** methods are difficult to sustain and fail to target the principle source of infection, the **animal reservoir**[3].

Since the 1980s, Rhodesian sleeping sickness has been spreading from its traditional focus in south eastern Uganda, to previously disease-free (though tsetse-infested) districts further north. Ironically, this spread is associated with **agricultural development**, including **restocking** with livestock. In hindsight, many cattle imported from sleeping sickness endemic areas were likely to have been carriers of the human-infective parasite[7,8,9.]. During the past six years, the disease has been introduced to six new districts of eastern Uganda and threatens to become sympatric with a long established focus of Gambian sleeping sickness in the northwest. When this happens, diagnosis and treatment of sleeping sickness will be severely compromised and there is a high risk that the disease will spread further[10,11].

The new approach is applicable wherever domestic livestock constitute a major source of infection and/or in transmission systems where tsetse feed predominantly on domestic animals e.g. **Uganda, Tanzania**, **Malawi**, **Kenya**, **Zambia**, **Sudan** and **DR Congo**.

In addition to controlling an important zoonotic disease, local cattle will be healthier and more productive due to the simultaneous control of animal **trypanosomiasis** (***nagana)*** and **impact** on **tick borne diseases** through restricted application of insecticide[12,13]

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

The output is primarily focused on the livestock sector, although it will also deliver benefits in the human health sector, through the control of an important and, if untreated, invariably fatal neglected zoonotic disease.

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?

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)?

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.

AHP- and LPP-funded research has developed and validated the restricted application approach to spraying cattle with insecticide – see *Tsetse control through restricted application of insecticide to cattle* in list of AHP RNRRS outputs and *Restricted application for tsetse control* in list of LPP RNRRS outputs.

It would be beneficial to cluster this output with two other AHP outputs that focus on sleeping sickness: see *Diagnostics that can identify human-infective trypanosomes in cattle blood* and *Informing policy development through dissemination of research findings* in list of RNRRS outputs. The former concerns the development of a blood sample collection and storage system and a sensitive diagnostic that can differentiate human-infective from non human-infective trypanosomes, and constitutes an invaluable system to monitor Rhodesian sleeping sickness control programmes: blood samples can simply and easily be collected from people, cattle or tsetse, the samples can be stored at room temperature and subsequently tested in the laboratory using highly sensitive and specific diagnostic tools. The latter output provides experience of influencing policy and attracting support for a public-private partnership through the generation and dissemination of high-quality research findings. Finally, the output could be clustered with outputs associated with ticks and tick-borne diseases; *Infect and treat method (ITM) for ECF control: a pro-poor vaccine against ECF.*

For livestock keepers in sub-Saharan Africa, the management of tsetse and trypanosomiasis forms only part of a wider livestock strategy and the prompt and accurate diagnosis of animal diseases is crucial for cost-effective management. Accordingly, there are synergistic links with the AHP output *Simple decision tools for diagnosis of endemic diseases in Africa.*

Since livestock are an integral part of mixed farming systems this output also links to the CPP output *Draught animal power* and the LPP's *Draught animal toolbox*.

Validation

B. Validation of the research output(s)

*10. **How** were the output(s) validated and **who** validated them?*
***(max. 500 words)**.*

The impact of block treatment of cattle in Uganda on trypanosomiasis and sleeping sickness was validated in collaboration with the Ugandan Ministry of Agriculture, Animal Industries and Fisheries (MAIFF), Makerere University, Livestock Health Research Institute (LIRI), Farming in Tsetse Controlled Areas (EU-FITCA) and the

Coordinating Office for Control of Trypanosomiasis in Uganda (COCTU).

FITCA carried out block treatment operations in 2002/3 in which 65,400 cattle in specific sub-counties were treated with trypanocidal drugs in Tororo, Iganga, Kamulu and Soroti districts (15% coverage per district). The project used molecular tools, developed by DFID-AHP, to monitor the operation's impact[1,14-19.] They showed this approach was highly effective against *T. b. rhodesiense,* which causes Rhodesian sleeping sickness in people[20]. For example in selected sub-counties in Kamuli district, Uganda, in November 2002, 19,000 cattle (85% of the cattle population) were block treated with trypanocidal drugs. At this time, the point prevalence of *Trypanosoma brucei* was 14% and around half the animals were carriers of human-infective *T. b. rhodesiense*. One year later, no cattle were found to be carrying human-infective *T. b rhodesiense*. Modelling studies indicate that to be successful, more than 86% of the cattle population in an area need to be treated with trypanocidal drugs.

Block treatment methods can be augmented by preventing subsequent re-infection by controlling tsetse. The added benefit of applying insecticide to cattle using the restricted application approach was examined in villages in south-eastern Uganda, which were endemic for sleeping sickness. This was tested through conducting a field trial involving 1000 cattle in 12 villages in Uganda in collaboration with LIRI, Makerere and University of Edinburgh. Cattle were treated with a curative trypanocidal drug to clear them of all trypanosomes and were subsequently treated monthly with deltamethrin insecticide sprayed on the legs belly and ears, that is using the restricted application protocol. Over the 6 month period of the trial, not a single animal became re-infected with *T. brucei*. Farmers also reported additional benefits: healthier animals carrying fewer ticks, which reduced the direct impact of these blood-sucking pests and lowered the risk of tick-borne diseases.

The combined methods (block treatment and restricted application follow up) are currently been evaluated at district level (September to November 2006) by a public-private partnership to 'Stamp Out Sleeping Sickness' (SOS). SOS partners include Makerere University, University of Edinburgh, Ceva Santé Animale, Cooper Uganda and Industi Kapital with support from the Ugandan Ministry of Agriculture, Animal Industries and Fisheries (MAIFF) and COCTU.

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 block treatment output was tested in south and east Uganda in semi-arid areas where cattle represent a significant component of mixed crop-livestock farming systems and where Rhodesian sleeping sickness is endemic. Block treatment impacts were evaluated at village level (in Busia and Tororo) in Uganda between 2003 to 2006 and at sub-county level between 2002-3 in Tororo, Iganga, Soroti, Kamuli and Busia districts.

Restricted application was trialled in villages in Tororo and Busia Districts, SE Uganda, between 2004-2005.

The combined methods (block treatment and restricted application follow up) are currently been evaluated at district level (September to November 2006) by a public private partnership to Stamp Out Sleeping Sickness (SOS). SOS partners include Makerere University, University of Edinburgh, Ceva Santé Animale, Cooper Uganda and Industi Kapital with support from the Ugandan Ministry of Agriculture, Animal Industries and Fisheries (MAIFF) and COCTU. In this larger-scale sleeping sickness control campaign more than 220,000 cattle are being treated with drugs and insecticide in the districts in Uganda newly affected by Rhodesian sleeping sickness. This involves treating over 85% of cattle in Kabaramido, Dokolo, Amolitar, Lira, and partial coverage of the cattle population in the affected sub-counties of Apac and Soroti districts.

Current Situation

C. Current situation

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

In Uganda, a public-private partnership, Stamp Out Sleeping Sickness (SOS), between the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF), the Coordinating Office for Control of Tsetse and Trypanosomiasis (COCTU), Makerere University, Edinburgh University, veterinary pharmaceutical companies (CEVA Santé Animale, France; Cooper Uganda), a private sector donor and local livestock owners, will treat more than 220,000 cattle with a combination of trypanocidal drugs followed by monthly spraying with deltamethrin using the restricted application approach. The intervention which is scheduled to run from September – November 2006 aims to alleviate human and animal trypanosomiasis, halt and reverse the northward expansion of Rhodesian sleeping sickness and prevent the foci of Rhodesian and Gambian sleeping sickness in Uganda from merging.

*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).***

Uganda: whole districts of Kabaramido, Dokolo, Amolitar, Lira, and selected sub-counties in Apac and Soroti and districts.

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

The impact of block treatment with trypanocidal drugs was assessed in 2003 in four districts of Uganda using new molecular tools for diagnosis. The initial trial of restricted application of insecticide was conducted in 2004/5 involving treatment of ca. 1000 cattle from 12 villages.

The large-scale sleeping sickness control campaign, SOS, was begun within one year of the research findings first being published in high impact peer-reviewed journals (Lancet and British Medical Journal). No steps are being taken to encourage the further spread of the output; rather the intention is to assess the impact and lessons learned from this campaign before scale-up to new situations and proceeding to a second phase in Uganda. SOS was initiated in September 2006 and involves combining drug treatment and insecticide application for more than 220,000 cattle in six districts where around two million people live.

In Burkina Faso, a trial of the restricted application of insecticide approach was performed in 2003 and involved the treatment of ca. 80 cattle. As a result, currently around 60 peri-urban dairy producers are regularly treating around 2500 cattle in the vicinity of Bobo-Dioulasso.

The use of the restricted application approach is expected to expand in both countries, since each has major tsetse control operations planned as part of the Pan African Tsetse and Trypanosomosis Eradication Campaign (PATTEC). These operations, supported by loans from the African Development Bank, aim eventually (up to 100 years) to eliminate tsetse from 15,000 km^2 of Uganda and 40,000 km^2 of Burkina Faso.

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?

The principle investigators and other partners in the research on which this output is based have been active and respected members of the international tsetse and trypanosomiasis community for up to 40 years. Access to a broadly-based network of scientists, veterinary and medical practitioners and administrators, policy makers, members of the private sector and journalists has greatly facilitated the establishment of the public-private partnership that is currently implementing SOS Phase One. It was fortunate that the publication of the landmark papers on the sleeping sickness situation in Uganda in 2005/2006, which highlighted the possibility of intervening by treating cattle with trypanocidal drugs, coincided with the desire by a leading veterinary pharmaceutical company – CEVA Santé Animale – to undertake a public good project to enhance their 'triple bottom-line' reporting profile. More fortune still was the fact that this attitude and desire was shared by CEVA's major shareholder, the pan-European private equity company Industri Kapital.

The output is in line with WHO's policy and recommendations with regard to the need for emergency action to prevent the convergence of the two forms of sleeping sickness in Uganda.

Sleeping sickness is widely recognised as a priority problem in Uganda and two unique government bodies, the Ugandan Tsetse and Trypanosomiasis Control Council and the Coordinating Office for the Control of Trypanosomiasis in Uganda, are testament to the seriousness with which the threat of sleeping sickness is taken in Uganda.

Publications in prestigious peer-reviewed journals, such as the Lancet and British Medical Journal, helped to increase awareness of the problem of sleeping sickness in Uganda and enhanced and galvanised veterinary and medical cooperation to tackle this important zoonosis. As a result of these publications, the story was picked up by the international mainstream press and, in turn, by local journalists in Uganda: publication of the story in Ugandan papers brought the issues to the attention of Ugandan ministers and parliamentarians, whose interventions led to changes in policy in Uganda with regard to sleeping sickness control.

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.*

Publication of papers describing this work in prestigious peer-reviewed journals, and subsequent uptake of the story in the international and local media interest, helped raise the profile of the deteriorating situation regarding sleeping sickness in Uganda and the possibility of tackling the problem using a new and attractive approach. Through a process of formal and informal meetings and interactions, a public-private partnership was formed, which led to the large-scale sleeping sickness control programme (SOS), based on treatment of cattle currently (September to November 2006) underway in Uganda.

Also in Uganda, restricted application of insecticide is being promoted as part of a wider dissemination project supporting interventions against trypanosomiasis in Soroti, Kabaramido, Lira, Apac, Gulu and Tororo districts where around three million people live. The dissemination is being undertaken by a partnership between the Co-ordinating Office for the Control of Trypanosomiasis in Uganda (COCTU), the EU-funded Farming in Tsetse Controlled Areas project (FITCA), media and marketing specialists (Wren*Media*, Steadmans Research Services), scientists from Makerere and Edinburgh University and veterinary pharmaceutical companies (CEVA, France; Cooper, Uganda).

In Burkina Faso, the restricted application of insecticide approach is being promoted to peri-urban dairy farmers by a French-supported development project.

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.

To enable this approach to sleeping sickness control to be more widely applied, both in the remainder of the Ugandan Rhodesian sleeping sickness focus and foci in other Africa countries requires:

- Basic epidemiological studies to be undertaken – made possible by the new, sensitive diagnostic tools – to investigate the animal reservoir in different settings.
- Validation of restricted application approach to spraying insecticide in *T.brucei gambiense* affected areas (DR Congo, S. Sudan, NW Uganda).
- Quantification of the extent of impacts of the control measures on other insect pests, ticks and livestock diseases, and also the implication for human health and wellbeing.
- Analysis of the results achieved under Phase One SOS campaign and derivation of lessons learned to inform future control campaigns in Uganda and elsewhere.
- Packaging of information about the approach and the lessons learned from SOS Phase One, in a variety of media and formats appropriate to different audiences.
- The sustainability of the approach depends on establishing the concept of, and developing a market that supports, the practice of regular spraying of cattle using the restricted application approach.
- Adoption of supportive evidence-based policies.

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

Funding is required to enable the basic epidemiological studies to be carried out in priority Rhodesian sleeping sickness foci where it is likely that cattle or other domestic livestock act as the major reservoir of infection and to investigate the full extent of additional impacts of the control measures.

Awareness needs to be raised about benefits of this approach to control of sleeping sickness: ‘healthy animals equates to healthier people’. This is needed at all levels, including policy makers and donors.

The practice of regularly spraying cattle with insecticide using the restricted application approach needs to become established. This requires cost-efficacy studies to demonstrate the benefits of the approach. There is a requirement for the creation of a market for insecticide and spray equipment: this entails ascertaining how farmers prefer to apply insecticide, the development of small packs of insecticide and inexpensive sprayers that meet farmers needs, establishment of a distribution network and a promotional campaign. Involvement of active private sector partners in the SOS campaign is clearly the key to the latter aspects.

The feasibility of using the restricted application approach to control *T. brucei gambiense* needs to be investigated.

19. What lessons have you learnt about the best ways to get the outputs used by the largest number of poor people?

The key to enabling Phase One of the SOS campaign to be implemented was the generation and dissemination of high-quality research findings, which told a compelling story. This inspired individuals and organisations to want to be part of the partnership, in the knowledge that something could be done that would make a difference: sustainable control of sleeping sickness.

Although the large-scale treatment campaign is still underway, lessons learned to date include the benefits of using final year veterinary students to administer the block treatment of trypanocidal drugs: this is cost-effective and provides the students with a valuable and much appreciated opportunity to gain experience of field work with livestock-dependent communities.

Cost. Current methods of tsetse control are too expensive for poor people. The restricted application of insecticide tackles this problem directly by making tsetse control through spraying cattle cheaper (< US$1 per year per animal) [21-25].

Animal health benefits. From a farmer’s perspective, the relationship between treating an animal with insecticide and preventing trypanosomiasis is not immediately obvious. Uptake of the restricted application approach by the poor may be improved by promoting collateral benefits such as control of ticks as a visible indicator of efficacy as well as for tsetse transmitted trypanosomiasis[26-28]

Human health benefits. The imperatives for tackling a fatal human disease, especially one with no prophylactic vaccine or drug and where even the cure is potentially fatal, differ from those for a veterinary disease[29-31]. This additional driver for adoption will be greater in areas where local people have awareness of the co-existence in cattle of animal trypanosomiais and zoonotic sleeping sickness.

Farming system. Uptake is likely to be greater in areas where livestock are an important component of the farming system and trypanosomiasis and sleeping sickness are significant and recognised constraints[32,33].

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.

Phase One of the SOS campaign is underway, scheduled to be completed in mid November, with monitoring and evaluation ongoing to June 2007, so it is too early to demonstrate impacts on poverty. However, if sleeping sickness can be sustainably controlled in five districts of Uganda, this will have a large impact on poverty. Currently it is estimated that for every person diagnosed and treated for sleeping sickness, 12 die undiagnosed[29,30].

There have been no formal studies of the poverty impact of the restricted application method. There however, is a considerable literature on cost-benefit analysis of tsetse control including comparisons between tsetse control methods (including insecticide-treated cattle) and between tsetse control and use of trypanocidal drugs[22-24]. Methods have been developed for spatial targeting of tsetse control on areas where benefits per km^2 will be high[24, 34].

No formal studies have been undertaken to consider the restricted application method, with its promise of radically cheaper control. Many cattle-owners across Africa can be classed as poor and the constant animal health inputs required to maintain animals free of endemic diseases in decentralized animal health systems can push farmers below the poverty line. In some areas farmers have evolved relatively sustainable strategies of prompt trypanocidal treatment of sick animals, particularly higher value ones such as draught oxen and lactating cows[23] but in others, a critical lack of disease awareness and perceptions hamper sustainable intervention[27].

The case for restricted application having a significant poverty impact rests on several pillars:

- Throughout the extensive zones of Africa where tsetse co-exist with farming systems involving cattle, a significant proportion of cattle-keepers can be classified as poor[35]
- Cattle for these people are multi-functional, providing a range of benefits, more or less quantifiable, including cash from sales of surplus stock, milk, meat, a savings and insurance function, a guarantee of standing in the community, draught power and manure [21,27,35].
- Some non-cattle-owners in these systems benefit from the ownership of cattle in the broader community through access to livestock products and draught-sharing arrangements[21,23.]
- In areas of zoonotic sleeping sickness, a high burden is imposed on communities by the threat of a fatal zoonotic disease[3].
- The costs to cattle-owners of living with trypanosomiasis, even where a relatively sustainable strategy

of trypanocidal treatment has been adopted include, not only the current costs of trypanocides but also losses of productivity associated with morbidity (e.g. loss of draught power or milk production)[22, 27,]

- A 90% decrease in the costs of tsetse control through the restricted application technique will make control more affordable to large numbers of poor farmers, and thus increase the net productivity of their livestock production.

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).

In Uganda, 17 districts are now affected by zoonotic sleeping sickness: 8 million people and 1.3 million cattle are at risk. It is too early to document how the poor have benefited from this new approach to control of sleeping sickness. More information is available, however, for one component of the control strategy: the restricted application of insecticide to control animal trypanosomiasis. Even in the absence of direct human health benefits, e.g. in Zimbabwean communal cattle keeping areas, it has been extrapolated that the control of tsetse achieved, in part, by insecticide-treated cattle has impacted on poor people's livelihoods[21,23].

- Effective tsetse control will reduce expenditure on trypanocides. Savings will be contributed towards other elements of household expenditure, thereby contributing indirectly to *financial capital* and through health, food and educational expenditure to *human capital*.

- Even where cattle mortality can be controlled by constant trypanocidal drug regimes, calving rates are still reduced by ca. 5% and thus herd growth is reduced[21]. Effective trypanosomiasis control can increase the size and value of herds and the potential availability of milk and animals for offtake. Healthier herds improve the functioning of livestock as stores of value, and indicators of social status. Together, these contribute to *natural, financial* and *social capital*.

Successful trypanosomiasis control interventions have a positive impact on households as a whole, by increasing household income and food supply. There are positive benefits on women, many of whom are *de facto* or *de jure* household heads. Financial savings on trypanocides and increased sales of livestock products can also contribute to health and educational benefits for children.

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)***

The interventions involved in the outputs are environmentally neutral and could replace alternative approaches to controlling sleeping sickness, such as large-scale aerial or ground insecticide spraying campaigns, which are potentially more environmentally harmful.

All tsetse control methods have two potential types of impact on the environment. One relates to the direct impact of the technique and the other concerns the consequences of improving the health and productivity of livestock.

The restricted application of insecticide method was developed, in part, as a consequence of concerns regarding the environmental impact of the standard (whole body) method of treating cattle with insecticide. The system reduces the amount of insecticide used and hence the impact on non-target organisms. Moreover, since the method does not require plunge dips, the environmental and health hazards associated with filling the dip and subsequently disposing of large volumes of insecticide are avoided.

With effective land-use planning and implementation, the use of insecticide-treated cattle to control tsetse 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)?

The output consists of a one-off treatment campaign in which cattle are block-treated with a long-used veterinary drug, followed-up by regular spraying of cattle with insecticide using the restricted application approach. The latter uses a very safe insecticide, deltamethrin, and the restricted application method involves the use of one-fifth of the conventional dose. The insecticide is applied mainly on the front legs, which is the preferred feeding site for tsetse. Neither of these interventions would be expected to have significant environmental impacts.

Increased productivity of cattle populations due to decreased mortality and morbidity rates could be offset by strong and growing demand for livestock products (the ‘Livestock Revolution’), forecast for the foreseeable future.

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?

One of the affects of climate change is likely to be spread of vector-borne disease into new areas as these become suitable habitat for the vector. In the case of sleeping sickness, new areas and populations are likely to become at risk. An effective, sustainable and proven control strategy that can rapidly be implemented in such areas will be a valuable weapon in such situations.

More generally, livestock play an important role in reducing vulnerability to natural and man-made disasters. The use of insecticide-treated cattle is particularly useful in this context since the treatment is applied to mobile cattle whereas other methods of control (e.g. targets, aerial spraying, sterile insect technique) are geographically fixed. Hence, livestock keepers fleeing a war zone, drought or flood can move with their treated cattle and still achieve some measure of control. By contrast, if the area had been controlled by, say, aerial spraying, the benefits would be lost.

Annex

Appendix 1. References

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