RIU

Easy diagnosis of livestock diseases

Validated RNRRS Output.

New methods have been developed to check the health of animals in areas of sub-Saharan Africa where vets are in short supply. One is a cheap, reliable low-tech instrument which can be used to test whether or not livestock are anaemic. Known as a haemoglobinometer, this easy-to-carry device could make a real difference to smallholder farmers since the presence or absence of anaemia is a key indicator of animal health in the tropics. A decision-support tool has also been developed to complement the haemoglobinometer. The colour-banded card helps users to match symptoms to eight major diseases and guides them towards the most likely diagnosis. The decision tool is already being used in Uganda and Eastern Zambia. However, great scope exists to expand its use.

Project Ref: **AHP07:**
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

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

UK, Uganda, Zambia,

Target Audiences for this content:

Livestock farmers,

AHP07

A. Description of the research output(s)

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.

Decision Support for Diagnosis

Effective decision support tools for diagnosis of endemic diseases of livestock in sub-Saharan Africa

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

RNRRS Animal Health Programme

EU Framework Programme 5, INCO-DC Concerted Action on Integrated Control of Pathogenic Trypanosomes and their Vectors (ICPTV)

EU Framework Programme 5, INCO-DC Concerted Action on Integrated Control of Ticks and Tick-Borne Diseases (ICTTD)

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.

R7597, R8318

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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.*

The outputs are:

(i) A simple, low-cost, **low-technology instrument** for measurement of **haemoglobin** in the blood of cattle and other livestock
(ii) A low cost **decision support tool** for the **diagnosis** of **endemic bovine diseases** in the mixed crop-livestock production system of sub-Saharan Africa
(iii) A generic methodology for development of **decision support tools** for **diagnosis** of **disease in livestock** in developing regions

Endemic diseases of sub-Saharan African cattle are a major constraint to sustainable rural livelihoods but their control is constrained by contraction of veterinary services, with devolution of diagnosis and treatment to less well trained cadres of veterinary service providers, change agents and non-professional cattle keepers who lack clinical knowledge or diagnostic tools. These outputs will improve the quality and accessibility of disease diagnosis to resource poor cattle keepers, through the development of a rapid, reliable and cheap haemoglobinometer as a diagnostic test for anaemia, a key indicator of the health status of animals in the tropics, and a decision support tool enabling simple diagnosis and treatment of these diseases.

Anaemia is a cardinal sign of many important vector-borne and other endemic diseases of cattle, particularly in the smallholder rainfed humid farming system. Anaemia or its absence has been shown to be an excellent indicator of bovine health in vector-borne or helminth disease endemic areas (Hendrickx et al., 1999). A novel, low-cost haemoglobinometer developed in conjunction with a commercial partner, enables animal health workers to measure anaemia in domestic livestock. The instrument is small enough to be carried on foot, on a bicycle or motor scooter, typical modes of transport for end-users, uses a sampling and measuring consumable costing a few pence, and is battery operated or solar powered.

The decision support tool has been developed as a diagnostic method complementary to the haemoglobinometer, and focuses on eight endemic bovine diseases, including trypanosomiasis, helminths and tick-borne diseases, which are widely recognised as key constraints to animal productivity. The tool is a colour-banded card utilizing a scoring system and differential diagnosis is performed by comparing observed clinical signs (including anaemia) with disease profiles and constructing a ranked list indicating the most likely diagnoses.

While low tech in its implementation, the decision support tool approach represents a generic method for encoding a wealth of expert opinion surveyed using the Delphi method, which could be applied to diseases of any species of livestock in any production system.

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*		

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

Main commodity: livestock
Other commodities: crops, through provision of manure and draught power.

Also, human health, through prevention of zoonotic diseases, such as trypanosomiasis, brucellosis, tuberculosis, cysticercosis etc.

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

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.

Added value would be obtained by clustering with the following animal health related RNRRS outputs on the circulated list:

(i) Sleeping sickness

- Diagnostics that can identify human-infective trypanosomes in cattle blood
- Treatment of cattle to eliminate the animal reservoir of *T.b. rhodesiense*

(ii) Integrated tsetse control

- Tsetse control through restricted application of insecticide to cattle

(iii) TB/Brucellosis

- Identification of risk factors for TB/Brucellosis and dissemination of messages to at risk populations

(iv) Control of worms in goats in southern Africa

- Development and dissemination of strategies for controlling nematodes in goats

(v) Delivery of research findings

- African Universities Veterinary e-learning Consortium (AUVEC)
- Creation of a common e-learning framework to develop, deliver and share learning resources across the African veterinary network
- CPD modules for animal health professionals.

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)**.*

The diagnostic decision support tool implemented as a printed, laminated decision support card (DSC) was initially validated during a workshop involving 30 experts on sub-Saharan cattle diseases, where the decisions of each pair of experts were compared to those of recommended by the card for a limited number of exemplar cases (see Magona et al. 2003). This provided some initial evidence of validity while also indicating the need for a more formal and field-based assessment.

A formal field trial was conducted in Uganda during 2004-2005. This trial was based around the involvement of 15 veterinary staff with a variety of levels of training. The trial was organised by one of the Ugandan project partners, LIRI, while the field staff were government employees in the Ministry of Agriculture, Animal Industries and Food. The trial comprised two field-based exercises with a training and dissemination workshop between the first and second phase (see Eisler et al. 2006).

During the first phase the diagnostic practices of the veterinary staff were monitored by means of a self-completed log book, using a standard recording template for each case encountered. Around 750 cases of diseased animals and their diagnosis by the 15 staff involved, over 5 districts in S.E.

Uganda, were recorded in this manner. A workshop was then organised by project staff to which the 15 field-based veterinary staff were invited. At this workshop they were introduced to the DSC and the associated diagnostic methodology. They were also given a set of cases to work on during the workshop to ensure that the DSC was being appropriately used. During the second phase of the validation the actions of the veterinary staff were again recorded, this time while using the DCS as part of the process. An assessment of both the differences in diagnostic practice as well as clinical outcomes and treatment was then carried out.

Diagnostic practice appeared to be significantly altered following the introduction of the DCS, most obviously in terms of the number and range of clinical signs observed by the practitioners. In addition the diagnosis suggested by the card was largely in agreement with that made by the more senior veterinary staff, suggesting that the card may be of particular benefit to less well trained livestock assistants, enabling them to engage in disease diagnosis tasks which would previously have only been possible through the less accessible and more expensive process of calling out a veterinarian.

The **low-cost** haemoglobinometer has been validated under laboratory settings, using (i) bovine blood samples titrated to known haemoglobin concentrations and (ii) commercially available haemoglobin quality assurance samples. A number of existing commercially-available haemoglobinometers have been validated for zebu and sanga cattle under field conditions during extensive longitudinal studies of endemic infectious disease in Uganda and Eastern Province, Zambia and the approach been demonstrated to be useful. Unfortunately these instruments are impractical for routine use under these conditions, see below. This assessment conducted by the Livestock Health Research Institute, Uganda, supported by the University of Edinburgh.

*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)**.*

Validation of the prototype **low-cost** haemoglobinometer was conducted in the UK (laboratory-based studies) 2001-2006. It is presently undergoing electrical compliance testing prior to human medical clinical trials and full-scale manufacture.

The haemoglobinometer concept has been validated widely in cattle in the field in Busia, Bugiri, Kamuli Soroti, and Tororo Districts Uganda, and in the Eastern Province of Zambia using currently available alternative instruments (2001–2006). These instruments provided proof of concept of the practicability of measurement of haemoglobin in cattle under endemic infectious disease challenge. However, none of these existing instruments is suitable for routine use in rural Africa, owing to two key constraints, (i) cost and (ii) requirement for a precise, quantitative pipetting step. For instance, the promising HemoCue™ is too expensive for routine use in resource poor farming communities; the unit has a high initial cost (ca £400) and individual tests require a new non-reusable cuvette costing approximately £1, putting it well out of reach of poor livestock keepers and the animal health workers who serve them.

The DSC was initially validated by 30 international experts on sub-Saharan cattle diseases. This exercise took place during a workshop held in Nairobi, Kenya in 2003, under the auspices of the ICPTV and RNRRS-AHP projects. Subsequently, field-based validation took place over eight months in 2004-2005 and was based in 5 districts of Uganda: Iganga, Kayunga, Sironko, Soroti and Tororo. This validation involved the diagnosis of disease in cattle within peri-urban and high potential production systems based on smallholder, rainfed humid farming. Individual animal health workers made use of the DSC in their own areas, among the communities in which they routinely practice

A further evaluation of the DSC has been on-going in the Eastern province of Zambia since the early part of 2006, based in Nyimba, Katete and Petauke 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****).*

The DSC is being used as a tool to support differential diagnosis by veterinarians across Uganda. Subsequent to the workshop and validation exercise a number of veterinary colleagues of the validating group requested access to additional cards. This uptake has happened despite the fact that there is not yet any formal channel through which the cards can be distributed to veterinarians, e.g. although the Ministry of Agriculture, Animal Industries and Food has expressed interest in taking on a training and dissemination role. In addition to veterinary staff, the DSC is also being used by animal health assistants. This not only improves diagnostic outcome but also acts to train these individuals in basic skills of clinical observation. Without the cards, diagnosis is frequently peremptory or omitted altogether and treatment is made on an ad-hoc basis; use of the cards promotes proper clinical examination of cases and prompts animal health workers to make a rational differential diagnosis and then administer treatment on this basis.

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).***

The areas where validation took place, i.e. within peri-urban and high potential production systems based on smallholder, rainfed humid farming, are primarily those where the system is being used; both in Uganda and latterly in Eastern Zambia. In order to be used in other contexts the knowledge coded on the DSC would have to be altered and some re-validation carried out. Some initial work on modifying the card to other countries (Southern Sudan and Rwanda) has been initiated.

The low-cost haemoglobinometer is not currently in use in Africa, since it is not yet widely available although the underlying principle of examining animals for the presence of anaemia is embedded in the DSC. Clinically, anaemia may be detected by examination of mucous membranes, such as the palpebral conjunctiva or the vulva, and in the absence of the haemoglobinometer or any non-subjective other means of assessing the erythron (i.e., the mass of haemoglobin containing red blood corpuscles or erythrocytes in the peripheral circulation and haemopoietic tissues), this is worthwhile. However, this approach is less sensitive and highly subjective and may be confounded by other factors. By using an instrument such as the haemoglobinometer it is far less likely that anaemia will be missed or misdiagnosed.

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

The DSC was adopted by practitioners immediately after its introduction at a project-sponsored workshop. Requests for additional cards came from veterinary colleagues of those using the DSC – i.e. the only mode of 'advertisement' that existed was word of mouth. It is difficult to know what proportion of veterinary staff in Uganda use the card now, just over one year since its introduction, but it has been widely adopted and usage appears to be increasing. One of the regrets of the project team was that there was not more provision for dissemination workshops as it was felt that the DSC is most effectively used in combination with a short training session. Such short workshops would also have allowed for observation of the impact of introducing the card to other types of users – such as minimally trained animal health assistant and indeed farmers themselves.

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).***

(i) The DFID RNRRS Animal Health Programme has encouraged interaction amongst investigators and collaborators across a wide portfolio of projects, including a number of themed meetings which have been of particular benefit in terms of exchange of ideas, results and hence capacity strengthening.

(ii) The EU Concerted Action on Integrated Control of Pathogenic Trypanosomes and their Vectors (ICPTV), coordinated by the PI of RNRRS Projects R7597, R8318 that led to these outputs. ICPTV has some 27 institutional partners, the majority in sub-Saharan Africa

(iii) The African University Veterinary e-Learning Consortium AUVEC (see relevant RiU proformas). AUVEC members include over 10 faculties of veterinary medicine in sub-Saharan Africa, chaired by Makerere University, Kampala, with the University of Edinburgh as a founder member having assisted in the creation of AUVEC with funding from DFID.

(iv) The interest, commitment and investment of the commercial partner (Elcomatic Ltd, Neilston, Renfrewshire) has represented an essential platform for development of the haemoglobinometer. http://www.elcomatic.co.uk/haem.html

(v) The institutions involved in developing the outputs described in this proforma worked closely with Government Ministries of Agriculture, Departments of Livestock Services, and Veterinary Departments in numerous sub-Saharan African countries, including Ethiopia, Ghana, Kenya, Uganda, Malawi, Nigeria, South Africa, Sudan, Tanzania, Zambia, and Zimbabwe.

(vi) Various other regional institutions and groupings have added valuable additional cohesiveness to the research process leading to these outputs:

- The Pan African Programme for the Control of Epizootics (PACE) and Pan Africa Rinderpest Control Programme PARC.
- The RTTCP and FITCA tsetse and trypanosomiasis control programmes
- The Programme Against African Trypanosomiasis (PAAT)
- The Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC)
- AU/IBAR.

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).***

There is on-going promotion of the DSC within Uganda by the Livestock Health Research Institute, working with veterinary officers in Government and other extension workers in a number of districts as described above.

Awareness of the DSC is also being raised in the Eastern province of Zambia through the current validation exercise being conducted by the Tsetse and Trypanosomosis Control Section of the Ministry of Agriculture and Cooperatives.

The haemoglobinometer methodology has been adopted by a commercial company (Elcomatic ltd.), which while sympathetic to the needs of animal health in the developing world sees its primary potential market as human health the developed world. The company has an agreement with the University of Edinburgh to allow marketing the instrument at a preferential rate in Africa, but its promotion and marketing in the developing world are unlikely to become a priority without further support from DFID in creating the necessary markets.

*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)**.*

Lack of awareness among policy makers, veterinary services and animal health professionals in Africa of the technological advantages and cost-effectiveness of both the haemoglobinometer and the DSC, as well as lack of availability of the haemoglobinometer in the marketplace are currently limitations to adoption.

Other than in the areas of Uganda and Zambia involved in its validation the diagnostic decision support tool is not yet widely available to animal health workers in most target countries. As a simple printed card, the costs of production are relatively trivial, but lack of awareness of its existence, and lack of training in its use are limitations for adoption by change agents in rural areas. Likewise, lack of awareness of the potential of decision support tools as a generic methodology for other diseases/livestock species/farming systems limits the uptake of the approach in a wider context.

At a more immediate practical level, the haemoglobinometer is currently subject to electrical compliance testing.

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).***

The most critical barrier to success with this type of methodological/educational input is one of professional scepticism and/or inertia. In this the involvement of many local disease experts in creating the card was critical to its credibility. In addition the organisation and delivery of the key workshop introducing the DSC by a locally recognised centre known for its research into animal health issues was important. One potential barrier of the DSC may unfortunately be in its simplicity – i.e. it was conceived as a low cost/minimal technology solution, but its very success in this respect may also make it seem like a less 'exciting' or scientific tool to the veterinary user. While the project team feel that the approach adopted was key to generating useable technology for the farming context being targeted (as opposed to the more complex computer-based diagnostic systems they had experimented with in the past) it is also possible that alternative delivery mechanisms for the knowledge in the DSC could increase its uptake (see below).

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).***

The outputs described in this proforma are not intended for direct use by poor people themselves, but by the various cadres of animal health workers that support them in maintaining the health of their animals. These include fully qualified veterinarians in government service and private practice, as well a range of paraprofessionals including veterinary assistants, animal health assistants and community animal health workers. Key to maximising the impact of these outputs on the lives of the poor is raising awareness of their existence, education with regard to their value, and training in their use. This will be best achieved by improved veterinary training and CPD for animal health workers.

In this context, the model used by the Stamp Out Sleeping Sickness (SoS) campaign in Uganda is of particular note, wherein ambulatory teams of final year veterinary students from Makerere University together with their lecturers, themselves qualified veterinary clinicians have been actively involved in treating hundreds of thousands of cattle with drugs and insecticides to control both human and animal trypanosomiasis. While so doing, they have been exposed to a wealth of clinical material representing the natural spectrum of infectious disease of cattle in the very areas in which they are likely to practice once qualified. In a second, wider phase of this campaign, it is anticipated that the same teams will be equipped with the decision support tools described in this proforma. This will have the immediate effect of bringing these tools to bear on large populations of cattle undergoing natural disease change, but also profound longer term effects in terms of educating the next generation of veterinarians in the use of these methods. It will also serve to raise awareness amongst other cadres of animal health professionals working within the region.

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 heads of state of the worlds most influential nations undertook in 2005 to "*continue the G8 focus on Africa, which is the only continent not on track to meet any of the Goals of the Millennium Declaration by 2015*" and to "*Support a comprehensive set of actions to raise agricultural productivity, strengthen urban-rural linkages and empower the poor, based on national initiatives and in cooperation with the AU/NEPAD Comprehensive Africa Agriculture Development Programme (CAADP) and other African initiatives*" (G8 Gleneagles Communiqué, 2005). Livestock underpin poor rural livelihoods in sub-Saharan Africa, but animal production is constrained by diseases, particularly infectious diseases, many of which are also zoonoses (Perry et al., 2002). The delivery of veterinary services in most developing countries was, until recently, considered to be the responsibility of the public sector. However, over the past four decades, economic constraints and the imposition of structural adjustment policies (SAPs) have led to a gradual decline in public sector investment in real terms and thus a reduction in the quality and quantity of services available to livestock keepers (Woodford, 2004).

Infectious livestock diseases in sub-Saharan Africa can usefully be considered in two distinct categories. Epidemic diseases, such as rinderpest, foot and mouth disease and contagious bovine pleuropneumonia, often referred to as transboundary diseases, have major implications for international trade in livestock and livestock products. Their control remains the prerogative and responsibility of governments and international organisations and they are generally managed by national and regional control programmes. In contrast, endemic infectious diseases such as tsetse-transmitted trypanosomiasis, tick-borne disease and helminthoses, are now regarded as 'Production diseases' or 'private good diseases' and the onus of their control falls to the individual farmer, with communities and local organisations providing support in decentralised and privatised systems. Endemic diseases, frequently parasitic and/or vector-borne, constitute a major economic problem in affected regions, reducing livestock product yields and devaluing farmers' investments. Annual costs have been estimated at US$700 million for African animal trypanosomiasis (Kristjanson et al., 1999), $168 million for East Coast fever (Mukhebi, A.W. et al., 1992) and, in the Southern African Development Community (SADC) alone, $37-47 million for heartwater (Minjauw et al., 2000). Despite considerable progress that has been made in the control of some of the more dramatic major bacterial, viral and protozoan diseases, the significance of production losses caused by less visible chronic diseases is becoming more evident than before. These remain responsible for significant losses which prevent much needed increases in productivity. This is particularly true for the infections of livestock with helminths, especially liver flukes, and gastro-intestinal nematodes (Over et al.,1992).

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*

The detailed economic impacts of the outputs of this proforma in individual countries has not yet been determined. This is in part because of the wide range of animal diseases and their individual impacts, the complex spatial and temporal variation in incidence and severity of these diseases, and the complex relationships among livestock, rural economies and livelihoods. Moreover, these outputs are unlikely to be used in isolation from other animal health related outputs in the RiU portfolio, (see Q.9), and the importance of synergies amongst the various outputs should not be underestimated. An example would be where animal health workers diagnose animal disease using decision support tools and use the resultant information not only as a rational basis for therapy of individual cases but also to inform wider use of interventions for instance restricted application of insecticide for integrated control of sleeping sickness, animal trypanosomiasis and other vector-borne diseases. (see also Q.19)

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.

Indirect environmental benefit will accrue due to improved targeting of veterinary interventions such as use of injectable drugs and topical use of insecticides and acaricides. Improved diagnosis of diseases will result in a reduction of inappropriate use of these products where they are not indicated, and hence a reduction in drug residues in animal products such as meat and milk and a reduction in environmental contamination with acaricides and insecticides. One example of this would be improved targeting of trypanocidal drugs, one of the most widely used categories of veterinary intervention sub-Saharan Africa; these drugs may be the only means of maintaining cattle productively in areas of high tsetse challenge, but may have adverse consequences when used inappropriately (Eisler et al., 1997).

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

None

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)***

Livestock are particularly important for people living in marginal zones, including pastoralists living in the more arid tsetse-infested regions of Africa. Such people are vulnerable to drought and to cope with this they move to less marginal habitats at certain times of year. These movements often involve balancing the availability of grazing and water against the increased risk of vector-borne and other parasitic diseases associated with more humid habitats. This coping strategy is increasingly compromised by government policies and encroachment of arable farmers, which in turn forces pastoralists to utilise habitats heavily infested with disease vectors such as ticks and tsetse. The decision support tools would provide pastoralists with a better strategy for reducing disease risk and hence decrease their vulnerability to drought. More generally, livestock provide an important hedge against socio-political and economic emergencies such as war and hyperinflation and improved animal health would also reduce vulnerability of people in tsetse-infested areas to these events.

Annex

Appendix 1. References & Further Reading.

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Appendix 2. Decision Support Card.

Decision Support System for Endemic Diseases of Zebu Cattle in SE Uganda

	Anaplasm.	Babesiosis	Cowdriosis	Fasciolosis	PGE	Schistosm.	Theileriosis	Trypanosm.
Anaemia or Pallor	4	2		2	3	4	1	4
Anorexia or Depression	2	2	4				3	
Ataxia or Abnormal behaviour			4					
Constipation	4							
Diarrhoea				1	3	1		
Dysentery						2	1	
Dyspnoea or Coughing							3	
Haemoglobinuria		4						
Icterus	1	2						
Lymph node enlargement							4	2
Pyrexia	3	4	4				4	1
Staring coat				2	2	1		3
Stunted growth or pot belly				2	3	2		
Submandibular ventral oedema				3	2			
Weakness	1	2	3	3	1	3		2
Weight loss	1			3	2	3		4

Instructions for use

Identify the rows of the table showing the clinical signs present in the animal. Add up the numbers in the 'disease' columns for these rows only. Compare the totals for each column. The heading of the column with the highest total is the most likely diagnosis. Note that an animal may be suffering from more than one disease, which will complicate diagnosis. The system is intended to assist individuals with veterinary clinical training, and all other available information should be taken into consideration.

(This system is a prototype for research purposes only. The authors accept no responsibility for the consequences of its use in clinical situations.)