Beating brucellosis and bovine tuberculosis

RIU

Validated RNRRS Output.

To boost livestock production and improve people's health, researchers in Tanzania have been working to increase people's knowledge of brucellosis and bovine tuberculosis—diseases which cause long-term illness in people and production losses in livestock. In Tanzania both diseases are a growing problem, and lack of knowledge is the major barrier to efforts to stop their spread. This work has involved identifying the groups most likely to be affected by the diseases and developing better ways of showing them how contamination can be avoided—such as boiling milk, and taking extra care when handling raw milk and placentas. Work to educate health practitioners and vets has also given good results, because diseases like brucellosis are often misdiagnosed and mistreated.

Project Ref: **AHP04:**
Topic: **5. Rural Development Boosters: Improved Marketing, Processing & Storage**
Lead Organisation: **Centre for Infectious Diseases, University of Edinburgh, UK**
Source: **Animal Health Programme**

Document Contents:

Description

AHP04

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

Geographical regions included:

Burkina Faso, Cameroon, Chad, Cote d'Ivoire, Ethiopia, Kenya, Mali, Mauritania, Senegal, South Africa, Tanzania, Uganda,

Target Audiences for this content:

Livestock farmers,

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.

Working title of output:

Identification of risk factors for tuberculosis (TB)/brucellosis and dissemination of messages to at-risk populations

Cluster: **Zoonoses**

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

RNRRS Programme; Animal Health Programme, Zoonoses cluster

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.

R7229 – *Mycobacterium bovis* infection of cattle and man in Tanzania
R7357 – Quantifying costs and risk factors of bovine TB in Tanzania
R7985 – The impact of brucellosis on public health and livestock reproduction in Tanzania
R7271 - Optimising milk production in small-holder dairy farms in Tanzania

Institutional partners: University of Edinburgh, Sokoine University of Agriculture, National Institute for Medical Research (all projects), Moredun Research Institute (R7229, R7357), Glasgow University (R7985, R7271), Liverpool University (R7985, R7271), Reading University (R7271).

*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 the identification of **risk factors** for TB/brucellosis and the identification of appropriate and effective **knowledge dissemination methods** for at-risk beneficiaries to (a) reduce the **human health burden** of these diseases in vulnerable populations, (b) improve **productivity in their livestock** and (c) **empower the beneficiaries.**

Brucellosis and bovine tuberculosis are widespread throughout Tanzania and are a cause of growing concern for **food security** and **public health**, both as a cause of a **debilitating illness** in people and through **production**

losses in **livestock**. For brucellosis, these losses arise as a result of abortions in **cattle** and **small ruminants**, whilst bovine tuberculosis results in loss of condition and carcass condemnations reducing income from sales and availability of meat.

Although **tuberculosis** is one of the most important infectious diseases in Africa, prior to the RNRRS projects in Tanzania, almost nothing was known about the contribution of *Mycobacterium bovis* (the cause of bovine tuberculosis) to the human epidemic. Similarly, although brucellosis was known to occur in livestock in Tanzania, very little was known about the associated disease burden or risk factors for infection.

Following conclusion of these RNRRS studies (**2001-2004**), **quantitative data** became available for the first time to assess the impact of bovine TB and brucellosis on human health, and to identify key **at-risk populations** and risk factors. Findings indicated that (a) **pastoral and agropastoral** communities were at greatest **risk** from bovine TB and brucellosis, and people with **poor levels of knowledge** living in **remote, marginalised** areas at particularly high risk from bovine TB; (b) bovine TB contributed substantially to the burden of human extra-pulmonary tuberculosis; (c) brucellosis affected 3% of people in pastoral and agropastoral communities, causing **prolonged disability** and a **high DALY burden**; (d) **misdiagnosis** of brucellosis was common and resulted in delayed and inappropriate treatment; (e) risk factors included consumption of raw milk and handling placental material.

Additionally, the project established close integration between **veterinary and public health** sectors, with **collaborative** studies involving **partnerships** between researchers from the Sokoine University of Agriculture (SUA) and the National Institute of Medical Research (NIMR). Each project incorporated a substantial **training** element, with **PhD training** of both veterinary and medical students within the project.

Substantial **capacity building** was achieved with establishment of laboratory facilities for culture and molecular diagnosis of bovine tuberculosis at SUA and NIMR and c-ELISA serology for brucellosis at SUA.

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

Livestock and livestock products
Human productivity (agricultural and other, currently constrained by poor health)

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

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

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

Smallholder rainfed humid	***Irrigated***	***Wetland rice based***	***Smallholder rainfed highland***	***Smallholder rainfed dry/cold***	***Dualistic***	***Coastal artisanal fishing***
X			*X*	*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.

Considerable value could be added by clustering this output with research outputs from several other key sources. Within the 'Research Into Use' initiative, these would include close links with other outputs within the Animal Health Programme cluster on **zoonoses** and **dissemination and delivery**. Links with the zoonoses cluster (rabies, R5406, and sleeping sickness, R7596, R8318) would strengthen existing veterinary-medical capacity, inter-sectoral integration and policy development for effective control of zoonotic diseases in East Africa. Links with the dissemination and delivery cluster would strengthen training on zoonoses within veterinary and medical curricula and help to develop continuing professional development (CPD), which is urgently needed to address the identified deficits in diagnosis, treatment and control of these zoonoses in Africa.

Linkages with **other RNRRS outputs** have also provide important added-value with respect to information on effective dissemination methods and materials in different farming systems in Tanzania. For example, identification of appropriate dissemination methods will incorporate data generated from projects from small-holder dairy famers ("Optimising milk production in small-holder dairy farms in Tanzania", **R7271**) and livestock keepers in Uganda ("Treatment of cattle to eliminate the animal reservoir of *T.b. rhodesiense*", **R8318**).

Further information on at-risk populations and dissemination methods for urban and peri-urban communities will be obtained from outputs derived from the **DFID project** ZXC0271 "An analysis of community health risk in relation to zoonoses from livestock keeping in a slum setting in Nairobi", a **JICA/DFID collaborative project** on "Urban and Peri-urban Livestock Farming in Uganda" and a **EU-funded project** (EDF 7, 6157 REG) on the risks associated with bovine tuberculosis and brucellosis in West Africa.

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 outputs have been adopted at various levels and by various groups, including end-users, district-level hospitals, government departments, intermediary organisations and international agencies.

In terms of **end-users**, an awareness of disease risks and willingness to adopt disease control measures was apparent among pastoral and agropastoral farmers during the research studies. More than 50% of farmers took up advice regarding removal of TB-infected animals (results from longitudinal studies - DFID final report, R7357**)**. The results were replicated in studies of brucellosis in Manyara and Dodoma regions, with test-and-slaughter control strategies adopted on several high-incidence farms in high-potential systems (Dr. G. Shirima, Animal Diseases Research Institute). Evaluation of the impact of these measures on the incidence of disease or productivity in livestock, or human disease, has not yet been carried out.

Uptake of outputs was also apparent among hospital medical officers within the study hospitals, with improved and enhanced diagnostic testing of suspected brucellosis patients (PhD study, NIMR, Kunda, 2006). These results have not yet been replicated in other parts of Tanzania, nor have their impacts in terms of reduced disease and disability burden been evaluated.

Dissemination messages have been adopted by several intermediate agencies (e.g. Wren Media, BBC World), with development of articles and radio programmes on public health issues relating to brucellosis/TB for dissemination in Africa (2003-2005). Zoonoses leaflets incorporating information on prevention of brucellosis/TB have been developed and distributed in collaboration with other projects (e.g. rabies projects in Tanzania – see zoonoses cluster, R5406).

Capacity-building has been validated in the form of quality control for laboratory diagnostic methods, with bovine TB diagnostic tests in Tanzania validated by the Moredun Research Institute (DFID final report, R7357, 2001**)** and the c-ELISA results for brucellosis diagnosis validated at the brucellosis reference laboratory, Veterinary Laboratories Agency, UK.

The identification of at-risk populations (e.g. pastoralists for brucellosis) and risk factors (e.g. raw milk consumption for bovine TB and brucellosis, handling placentae/assisted calving for brucellosis) has been validated through peer-reviewed publications (Mfinanga et al., 2004; Shirima, 2005; Cleaveland et al., 2006; Kunda, 2006 - see Bibliography in Annex C for details).

The institutional outputs of the projects have been evaluated in several reports, including: Shaw and Sibanda (2000) as part of a DFID evaluation; Coleman (2002) evaluating the impact of zoonotic disease on the poor; WHO/

DFID (2005) in relation to control of neglected diseases and poverty alleviation. Institutional impacts relate principally to increased awareness within WHO and collaboration among different sectors in Tanzania, resulting in formal establishment of an inter-ministerial commission on zoonoses and recognition of zoonosis research and control as a priority for NIMR (2005).

More formal evaluation of outputs of potential dissemination methods and material have been conducted by the small-holder dairy project (R7271), using a randomised controlled trial and validated by peer-review publications (Bell et al., 2006) to evaluate three knowledge dissemination methods (a diagrammatic handout, video and village meeting).

Relevant to these outputs is the **validation of local radio** as an effective way of communicating health messages, which was carried out by the sleeping sickness project (R8318) in collaboration with Wren Media and local partners in Uganda.

*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)**.*

R7229, R7357: Most of the validation has taken place in northern **Tanzania**, in three regions (Manyara, Arusha and Mara) with livestock-keepers and medical officers being the principal target group. Advice concerning disease control in livestock has been adopted in **agropastoral and pastoral** communities, involving **semi-arid** and **high potential systems,** and a range of farming systems including smallholder rainfed dry/cold and smallholder rainfed humid. Advice on removal of infected animals was taken up by livestock owners from 2000-2004, diagnostic advice was taken up clinicians in district hospitals from 2004 to the present date.

R7271: This study was carried out in **Tanga and Iringa** regions in **Tanzania** between 1999 and 2002. In Tanga, the study involved 256 smallholder dairy farmers in 36 villages (12 each in rural, **peri-urban** and urban areas). Tanga region comprises nine agro-ecological zones, and can be subdivided into areas of low, medium and **high potential** for dairying, primarily comprising **smallholder rainfed humid systems**. The study in Iringa region involved 110 farmers in 28 different villages, (11 rural, 8 **peri-urban** and 9 urban). Iringa region comprises two different agro-ecological zones, including **high-potential** zones, and **smallholder rainfed humid** and **smallholder rainfed highland** systems. Results showed no significant difference between respondents in rural, peri-urban or urban areas, suggesting that the knowledge dissemination methods used were appropriate for beneficiaries in each of these areas. These studies were carried out from 1997-2000.

R8318: Messaging outputs in Uganda were validated in Soroti District and Mukono District, involving **high potential** and **peri-urban smallholder rainfed farming systems** during early 2000s.

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 outputs are currently being used by:

The **World Health Organization** is using quantitative data on brucellosis/bovine TB from Tanzania to inform estimates of the global burden of food-borne diseases

The **Tanzanian Government** (Ministry of Health, Ministry of Livestock Development, Ministry of Natural Resources and Tourism) has greater awareness of the importance of intersectoral collaboration, the need for information on zoonotic diseases, and increased capacity through post-graduate training of medical and veterinary staff in zoonotic disease investigation.

Tanzanian research institutions (SUA/NIMR) are using the diagnostic methods developed to provide reliable results for detection of brucellosis and bovine tuberculosis in human and animal populations.

Livestock-keepers on several large farms with a high incidence of brucellosis are currently using test-and-slaughter methods to control the disease.

The **Livestock-for-Life programme** (**Wellcome Trust**) is using a bovine tuberculosis network in sub-Saharan Africa based on the model of the Tanzanian study for integrating sectors and capacity building.

Medical officers within district hospitals are now trained to recognise clinical signs that require laboratory testing for brucellosis.

Some members of the **general public**, including livestock-keepers are now aware of the importance of boiling milk to reduce disease risks. This has been achieved with large mural displays, leaflet distribution and household-level discussions.

*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 **Livestock-for-Life bovine TB programme** is operating in sub-Saharan Africa, including T**anzania**, **Kenya**, **Uganda**, Senegal, Mali, Mauritania, Côte d'Ivoire, Burkina Faso, Chad, **Ethiopia**, **South Africa**, Cameroon (PSA countries highlighted).

District hospitals with improved brucellosis recognition are in the study regions of Manyara and Arusha, northern Tanzania.

Livestock keepers adopting test-and-slaughter disease control methods are in Dodoma and Manyara regions, Tanzania (**high-potential systems**).

Public awareness murals are placed in key locations in Arusha and Manyara region, Tanzania, including **urban** and **rural** district centres (e.g. Arusha, Babati); and leaflets have been distributed in Arusha region.

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

Dissemination messages that address the zoonotic health risks (through leaflets, murals, radio broadcasts and household/hospital discussions) were rapidly adopted in the study areas (during the duration of project activities), but were (and are) geographically limited to the study areas only as a result of the limited 3-year timescale and funding available within the projects. Although these dissemination activities have not been maintained beyond the end of the research projects, the knowledge acquired is expected to persist for several years, although there is no doubt that dissemination needs to be reinforced at regular intervals.

The governmental and institutional impacts have been widely adopted and are expanding in use due to dissemination through the World Health Organization and the Wellcome Trust Livestock-for-Life programme. The uptake of outputs on disease burden occurred relatively rapidly (e.g. 2002 Coleman report on zoonotic disease impacts on the poor), and continues to be used (e.g. in the 2006 initiative by WHO for the global estimation of food-borne diseases)

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 principal platforms that have assisted with the promotion of outputs and capacity building include:

Meetings and workshops bringing together different institutions across different sectors, including DFID zoonosis meeting (Nairobi, 2005)), NIMR annual conference that incorporated a full-day on zoonosis research outputs (2005), and WHO/DFID workshops (2005).

Inter-sectoral collaboration. The establishment of an inter-ministerial commission on zoonoses has raised the profile of this group of diseases. Memoranda of understanding established between the veterinary and medical research sectors in Tanzania (SUA/NIMR) and collaborative engagement at all levels, including field studies, hospital research and laboratory diagnostic activities has been invaluable.

Capacity-building to provide the appropriate laboratory facilities at both NIMR and SUA and training of medical/ veterinary staff at both institutions.

Postgraduate and professional training for both medical and veterinary researchers in Tanzania (5 Tanzanian PhDs obtained through UK Universities, MSc training in Tanzania, technical laboratory training both in Tanzania and overseas).

Freedom for researchers to develop research outputs on return to Tanzania (e.g. Prof. Kazwala, Dr. Mfinganga) and to continue to act as advocates for zoonoses prevention and 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 **(max 200 words).***

For bovine tuberculosis, promotion in **Tanzania** is focused towards a full assessment of the true human disease burden, with completion of a DFID project on quantifying the contribution of bovine tuberculosis to human cases of pulmonary tuberculosis ("Quantifying the prevalence of *Mycobacterium bovis* in human pulmonary tuberculosis in Tanzania"). Outputs from the earlier RNRRS projects are being promoted on a wider geographic scale through the Livestock-for-Life project "Effective management of bovine tuberculosis in sub-Saharan Africa" funded by the Wellcome Trust, which aims to promote capacity-building, strengthen public education, and promote safe consumption of milk through partnerships with key stakeholders in a **wide range of countries in East and West Africa**. This is planned to cover the period 2006-2010.

Very little specific promotion on brucellosis is currently taking place in Tanzania or elsewhere in Africa.

*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)**.*

- Limited time scales and funding within research projects to allow development and dissemination of outputs.

- Weaknesses in the national veterinary services, partly as a result of structural adjustment policies which have tended to consider all animal health activities as a private agriculture technical service, with little account taken of the public good or public health aspects of animal health services.

- Social exclusion of key individuals, particularly women and people with low social ranking (e.g. cow boys in the smallholder dairy sector).

- The remote location of some of the most vulnerable households, posing logistic and financial constraints to effective dissemination of messages.

- Low education and literacy rates among some of the key recipients (e.g. 12% 'cowboys' in the smallholder sector are illiterate - R7271, women and people living in remote locations).

- Lack of understanding of the milk supply and distribution networks, the complexities of milk consumption practices, and cultural factors influencing these practices.

- Lack of an effective regulatory framework in Tanzania for ensuring the quality of milk sold for public consumption.

- The disproportionately high number of extreme poor among those most at risk, which would constrain the dissemination of some types of messages (e.g. those using radios).

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).***

- Longer-term cycles of support to take research through to dissemination and implementation.
- Recognition of public good services as part of the responsibilities of animal health services, with concomitant resources made available.
- Development of public-private interactions with investment of the private sector into dissemination.
- Empowerment of groups suffering from social exclusion.
- Identifying knowledge intermediaries who can translate outputs into messages for end-users , making them relevant and accessible.
- Use of knowledge dissemination methods that account for (a) poor literacy or illiteracy, (b) poor visual literacy, (c) remote locations and (d) extreme vulnerable poor with few assets.
- Involvement and interest of political leaders and other advocates.
- Establishment and implementation of regulatory structures for sale of milk.
- Development of an integrated national policy for control of bovine tuberculosis and brucellosis.

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).***

Without empowerment, there is a risk that key end-users will be missed, including women (preparation of milk), remote and assetless poor, pastoralists and semi-nomadic communities without well-defined institutional access.

Linking changing practices to direct benefits, provides an incentive for change, as seen with rabies control measures whereby communities recognised the link between dog vaccination and the control of rabies in their communities.

In general, people are eager to access knowledge and learn about disease risks, but must be given the opportunity to do so.

Beneficiaries should be sensitised to outputs prior to actual dissemination of messages. For example, campaigns could start with a branded awareness campaign and then move onto actual dissemination of key messages, such as ‘boil all milk’.

Radio messaging has been demonstrated as an effective means of disseminating public health messages relating to sleeping sickness in rural Uganda, and is not limited to households having ownership of radios as messages can be delivered through radios in public locations.

Piloting of dissemination materials is essential to ensure that local situations and images are depicted in all materials (to aid recognition), and ensure that all messages are locally relevant.

Schools and school children have proved an effective route of dissemination for rabies and sleeping sickness, with messages not only reaching the target child audience (in the case of rabies risks), but also resulting in feedback to adults in the household.

Awareness of health benefits of a given measure can create demand from the community, generating political will (e.g. rabies control in Tanzania) and a demand for supply of healthy products (e.g. premiums could be paid for pasteurised milk).

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.

To date, most impact of the brucellosis/TB projects has been at institutional level, with little direct impact on poverty. Where current impacts exist, these are geographically limited to the study areas in **northern Tanzania** and relate to improved diagnosis and treatment of brucellosis cases. This is expected to have reduced the burden of disease and disability, as well as the costs of treatment, but these impacts have not been formally quantified.

The impact of ‘boiling milk’ messages and other measures to prevent zoonoses has not been evaluated in terms of impact on poverty or human health.

Most of the studies listed relate to evaluating disease burden and identifying at-risk populations:

Shaw, A. and Sibanda, L. (2000) Evaluation of selected livestock research themes 1988-1999. Final Report for DFID. Landell Mills Ltd.
Evaluating the public health, institutional and institutional impacts of bovine tuberculosis research

Coleman, P. (2002) Zoonotic diseases and their impact on the poor. In: Perry, B.D., Randolph, T.F., McDermott, J. J., Sones, K.R. and Thornton, P.K. (2002) Investing in animal health research to alleviate poverty. International Livestock Research Institute (ILRI), Nairobi, Kenya.

Evaluation of the disability burden (DALYs) of bovine tuberculosis in humans in Tanzania.

Mfinanga S.G.M., Morkve O., Kazwala R.R., Cleaveland S., Kunda J., Sharp M.J. and Nilsen R. (2004) Mycobacterial adenitis: role of *Mycobacterium bovis*, non-tuberculous Mycobacteria, HIV infection and risk factors in Arusha, Tanzania. *East African Medical Journal*, 81. (4):171-8.
Quantifying the contribution of M. bovis to the human tuberculosis epidemic.

Shirima, G. (2005) The epidemiology of brucellosis in animals and humans in Arusha and Manyara Regions of Tanzania. PhD Thesis, University of Glasgow.
Assessment of abortion losses in cattle and small ruminants as a result of brucellosis infection; identification of infection prevalence and risk factors for livestock.

Bell, C.E., French, N.P., Karimuribo, E., Ogden, N.H., Bryant, M.J., Swai, E.M., Kambarage, D.M., Fitzpatrick, J.L. (2005) The effects of different knowledge-dissemination interventions on the mastitis knowledge of Tanzanian smallholder dairy farmers, *Preventive Veterinary Medicine*, 72: 237-251.
Evaluation of knowledge dissemination methods in the smallholder dairy sector in Tanzania.

Kunda, J. (2006) The epidemiology of human brucellosis in northern Tanzania, with reference to other zoonotic diseases. PhD Thesis, University of Edinburgh
Evaluation of the burden of human disease in terms of DALYs and costs of treatment at household levels; identification of risk factors for human disease.

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*

Little quantitative evidence is available to demonstrate how adoption of the outputs has benefited the poor. The outputs have been adopted in only limited geographic areas and, although these are anticipated to have had an impact as described above, little quantitative data are available.

Empowerment of farmers through increased knowledge was quantified as part of the smallholder dairy project, with an anticipated improvement in livestock health and productivity resulting from changes in milking practices, however this has not been quantified in terms of poverty impact.

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.

In the past, deterioration in livestock production has led to a significant expansion of cultivation in wildlife areas (e. g. Ngorongoro, Tarangire) leading to disruption of wildlife migration patterns and degradation of important habitats. Improved livestock productivity in pastoralist areas will have beneficial environmental impacts by reducing land-use pressure in ecologically-sensitive areas, such as the Ngorongoro Conservation Area, which is a World Heritage Site located in a high-risk area for brucellosis and tuberculosis.

Control of brucellosis and bovine tuberculosis in livestock is likely to have direct benefits for wildlife, reducing the risk of transmission from cattle to wildlife in areas with high rates of contact between livestock and wildlife (e.g. Arusha Region). Several important wildlife populations in Tanzania (buffalo, impala) are known to be infected with brucellosis, which may have contributed to population declines in the past (e.g. Serengeti buffalo). Although the impact of bovine tuberculosis on Tanzanian wildlife is not known, the infection is widespread in the national parks and potential effects may be severe, given the devastating outcome of bovine tuberculosis infection in Kruger National Park wildlife.

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

The only anticipated adverse environmental impacts relate to the increased demand for fuel for boiling milk and burning placental material, which may increase deforestation rates in some areas.

In the absence of protective clothing (gloves) the use of plastic bags may be promoted as a means of protecting hands from contamination during handling of placental material, which may increase litter volume (or alternatively may provide an additional value and use for plastic bags which may decrease litter volume).

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)***

There are no anticipated impacts other than the reduced burden of illness and disability.

Annex

ANNEX C. Bibliography

Anderson, D.M. and Broch-Due, V. (1999) The Poor Are Not Us: Poverty and Pastoralism. Oxford University Press, Oxford.

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Bell, C.E., French, N.P., Karimuribo, E., Ogden, N.H., Bryant, M.J., Swai, E.M., Kambarage, D.M., Fitzpatrick, J.L. (2005) The effects of different knowledge-dissemination interventions on the mastitis knowledge of Tanzanian smallholder dairy farmers, *Preventive Veterinary Medicine*, 72: 237-251.

Cleaveland, S., Shaw, D.J., Shirima, G., Kazwala, R.R., Mfinanga, S.G, Eblate, E. and Sharp, M. (2006) *Mycobacterium bovis* in rural Tanzania: risk factors and patterns of infection in human and cattle populations. *Tuberculosis (In press)*.

Cleaveland S**.,** Mlengeya T., Kazwala R.R., Michel A., Kaare M.T, Jones S.L., Eblate E., Shirima G.M. and Packer C. (2005) Tuberculosis in Tanzanian wildlife. *Journal of Wildlife Diseases* 41(2): 446-453.

Coleman, P. (2002) Zoonotic diseases and their impact on the poor. In: Perry, B.D., Randolh, T.F., McDermott, J. J., Sones, K.R. and Thornton, P.K. (2002) Investing in animal health research to alleviate poverty. International Livestock Research Institute (ILRI), Nairobi, Kenya.

Karimuribo, E.D., Fitzpatrick, J.L., Bell, C.E., Swai, E.S., Kambarage, D.M., Ogden, N.H., Bryant, M.J. and French, N.P. (2006) Clinical and subclinical mastitis in smallholder dairy farms in Tanzania: risk, intervention and knowledge transfer, *Preventive Veterinary Medicine*, 74: 84-98.

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