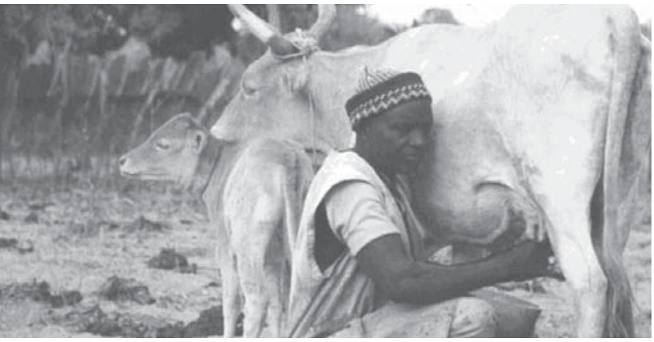

ILRI Manuals and Guides No. 5

Guidelines for assessing environmental and socio-economic impacts of tsetse and trypanosomiasis interventions

J. M. Maitima, L. C. Rodriguez, M. Kshatriya and S. Mugatha

ILRI
International Livestock Research Institute

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Report to the United States State Department

and

African Union's Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC)

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The International Livestock Research Institute (ILRI)
P.O. Box 30709 Nairobi 00100, Kenya

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For Further Information please contact Joseph M. Maitima

Email: j.maitima@cgiar.org

Tel: +254 20 422 3000

Fax: +254 20 422 3001

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Foreword

Tsetse-transmitted trypanosomiasis in both people and domestic animals is a critical constraint to economic development in Africa. Economic losses have been estimated at over US$1.3 million dollars annually. In addition, about US$30 million per year is estimated to be spent on prophylaxis and treatment. The Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC), has designed an extensive program in support of the eradication of tsetse and trypanosomiasis in sub-Saharan Africa, through a range of vector and disease management techniques integrating suppression, and eradication technologies. These interventions are likely to have significant environmental and socio-economic impacts that will be felt far beyond the target organisms, populations and regions where they will be implemented. It is therefore important that the design and implementation of PATTEC project activities lead to sustainable development outcomes. Sustainable development interventions need to be based on scientific evidence. To be useful for decision making, such scientific evidence must be relevant and responsive to the needs of policy and other decision-makers who are looking for practical research and development options to reduce poverty and in sustainable land management.

Improved technologies, policies, and institutions are central in efforts to control tsetse and trypanosomiasis. Alternative control strategies have direct and indirect impact on the environment as well as on livestock keepers and other poor people who depend on livestock for their livelihoods. Understanding the direct and indirect environmental and socio-economic impact of alternative control strategies is important to sustain livelihood benefits, enhance long term livestock and crop productivity and safeguard the integrity of the natural resource base for use by future generations. Careful evaluation of project impacts that provides timely information to decision makers is an important strategic input in the design and implementation of PATTEC investments. Given the multi-dimensional impact of project interventions, it is important that impact is assessed from inter-disciplinary perspectives for the results to have practical policy relevance and operationally useful.

This book responds to the expressed needs of decision makers and impact assessment practitioners who are looking for strategic guidance and practical information for evaluating the impacts of tsetse and trypanosomiasis interventions. It synthesizes information on key challenges in assessing impacts of natural resource interventions and provides a conceptual framework for assessing impact as well as guidelines and methods for assessing environmental, economic, and social impacts of project interventions. It also provides information on integrated approaches for assessing impacts. Practical advice is provided on the appropriateness, data needs, and resource requirements for each method that is described. The diversity of the methods and tools described in the book makes it a key reference source for the design, implementation, and evaluation of PATTEC projects.

Carlos Seré
Director General
International Livestock Research Institute
Nairobi, Kenya

Preface

Since prehistoric time man's survival and prosperity on earth has depended on not only the availability of natural resources but also on the richness and the potential of these resources to provide goods and services. The richer and probably the more diverse these resources are the higher are the chances that they will provide the necessary goods to support life, including that of mankind. The natural resources are comprised of spatially variable biophysical systems thriving under complex dynamic interrelated processes full of progressive and feedback loops and cycles that utilize and recycle energy within and between organisms, populations, communities, ecosystems and, to a larger scale, across landscapes in a manner that is self regulating.

Land utilization for agricultural development is based on intercepting these processes so that production of one or more selected commodities—the agricultural produce—is maximized. In so doing the producer or cultivator modifies the ecosystem or landscape into a desired agro-ecosystem (crops or pastures of choice) that to a large extent is no longer connected to the natural processes of recycling of energy and matter beyond its bounds. This therefore becomes a man managed ecosystem where production of the desired commodities is maximized and the natural self-regulation mechanisms are altered or changed. The newly created agro-ecosystems will need to operate within certain thresholds; outside these thresholds the productivity of the very agricultural commodities that the cultivator strives to produce will be affected. Such alterations will affect essential processes such as food chains and energy transfer, pollination, seed dispersal and germination, biodiversity, soil fertility, water availability and quality among others generally associated with healthy heterogeneous habitats.

To achieve sustainable development, there is need to understand the patterns and processes that govern production and land use not only to maintain the essential bio-physical properties but also to justify the need for making these investments, the efficiencies in which the interventions are implemented, and the achievements made in each intervention.

Tsetse and trypanosomiasis interventions are aimed at freeing land from the constraints of animal and human trypanosomiasis so that people can settle and profitably participate in agricultural production. The tsetse and trypanosomiasis freed areas are characterized by clearing of natural vegetation to give way for farmlands and grazing lands, intensification of agricultural production by the integration of cropping and livestock production systems, and increased human settlements among others. All these activities trigger changes in the environment that should be assessed and monitored.

Scientific tools for assessing and monitoring these changes are now made available in this book and if applied they will provide investors with current knowledge of the status and processes to guide not only the implementation of tsetse and trypanosomiasis interventions but also the sustainable utilization of the freed lands.

Joseph Maitima
August 2007

Executive summary

In the past numerous efforts to control trypanosomiasis, largely focussed on reduction of the abundance and distribution of the vector tsetse flies. However, all gains made through these control efforts are short lived due to resurgence of fly populations and disease prevalence in the controlled areas. Based on the experience of past control failures to sustain low tsetse populations, the African Union is promoting the elimination of the tsetse flies to eradicate the disease from the continent through the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) using government resources and support from the African Development Bank and other development agencies

Eradication has costs and benefits that need to be evaluated to estimate the viability of the investment and the sustainability of the interventions. All interventions on tsetse control and eradication have expected environmental and socio-economic implications depending on the approach used and the place where the control is undertaken. The direct and indirect effects of the tsetse and trypanosomiasis (T&T) interventions should therefore be evaluated across the natural, social and economic systems to properly estimate the costs and benefits of the eradication campaign.

These natural, economic and social systems are dynamic and complex. They exhibit non-linear behaviour and spatial and temporal lags in their response to T&T interventions, making it difficult to estimate their direct impacts on an individual system. In addition, the systems are linked and interdependent. In consequence, interventions on the natural systems can have indirect effects on the economic sector and human societies and in a similar way impact on the economy or society can have indirect effects on the natural environment. Understanding how the natural, economic and social systems are inter-linked and inter-dependent is necessary to identify the direction of the flows and the magnitude of indirect effects of T&T interventions to estimate with higher accuracy the costs and benefits of the eradication campaign, identify areas where further interventions are need to avoid negative feedback and design strategies to mitigate adverse effects across systems.

Considering the complex nature of the involved systems, their inter-linkages and feedback mechanisms, assessing the impact of T&T interventions could be a difficult task. The challenge is to understand and quantify how the interventions directly affect the environmental, economic and social systems, and how the indirect effects of an intervention in one system spreads through the others affecting their processes and modifying the flow and direction of the linkages between them. Such assessments require first a conceptual framework to help map out the main cause–effect relationships and response patterns. Secondly, there is a need for guidelines on how to assess the impacts to target the right components or groups in the system and apply the right methods and tools to quantify the effects and promote informed decision.

The purpose of this document is to guide development agencies, project implementers and other T&T eradication stakeholders to identify appropriate options for assessing impacts of T&T interventions based on their target level of analysis, available resources and constraints.

Here we present four broad categories of methodologies for impact assessment. These include: a) methods for assessing environmental impacts, b) methods for assessing economic impacts, c) methods for assessing social impacts and d) methods for integrated analysis and scenario development. Each of these methods contains tools to assess the impacts across different spatial and temporal scales. These tools contain key measurable variables that can be used as indicators to track environmental, economic and social changes and evaluate the achievement of project objectives.

1. Levels and methods for environmental impact assessments

Environmental impacts due to T&T interventions have been a major concern in the past. The methods to estimate environmental impacts contain different tools to assess the impacts of the interventions at different hierarchical levels. These levels are:

- **Individual:** impacts of interventions on different organisms (target and non-target)
  - **Methods:** *counting; scoping; and chemical toxicity analysis*
- **Population:** impacts of interventions on changes in abundance and distribution of individuals
  - **Methods:** *transects; trapping; and capture-mark-release-recapture*
- **Communities:** impacts of interventions on changes in species composition and structure in a defined area
  - **Methods:** *fogging; sweep netting; quadrats; transects at community level; time series species count; and stratigraphic correlations*
- **Ecosystems:** impacts of interventions on changes on biotic and abiotic processes and functions
  - **Methods:** *analysis of chemical pollution risks; environmental participatory rural appraisal (PRA); soil analysis; and water analysis*
- **Landscapes:** impacts of interventions on changes in biotic and abiotic processes across ecosystems
  - **Methods:** *land tenure analysis; cropping systems analysis; remote sensing; map overlays; and geographic information analysis*

2. Levels and methods for economic impacts assessment

Traditionally, the economic impacts of T&T interventions have been focused on the direct and indirect costs of the disease. This section describes different tools to assess those impacts and presents a series of tools that can be applied to estimate the economic impact of T&T interventions at different levels and quantify in economic terms the environmental impacts. These levels are:

- Herd level: impacts of interventions on animal health and productivity
  - **Tools:** *gross marginal analysis; break-even analysis; partial budget; decision analysis; investment appraisal; and dynamic herd models*
- **Farm/household levels:** impacts of interventions on farming/agricultural systems
  - **Tools:** *optimization approaches; and simulation approaches*
- **Regional/national/international level:** impact of interventions in other sectors of the economy and society
  - **Tools:** *cost–benefit analysis; economic surplus; input–output and social accounting models; partial equilibrium models (single sector and multi-market models)*

3. Levels and tools for social impact assessment of Trypanosomiasis interventions

This section describes different tools to assess the social impacts of T&T interventions at different levels of analysis. These levels are:

- **Beneficiary level:** impacts of interventions on the target human groups
  - **Tool:** *beneficiary assessment*
- **Stakeholders level:** impacts of interventions on the different beneficiaries and non-beneficiaries groups and organizations involved or affected by the intervention
  - **Tools:** *participatory appraisal and stakeholder analysis*
- **Society level:** impact of interventions on the society
  - **Tools:** *social capital assessment; and social impact analysis*

4. Methods for scenario analysis in T&T intervention

This section describes different tools to carry out scenario analysis to assess the environmental, economic and social impacts of T&T interventions. These tools are qualitative and quantitative and fall into three broad categories. These categories are:

- **Participatory method:** a qualitative approach to estimate the impacts of interventions on the environmental, economic and social systems based on a series of meetings with various stakeholders.
- **Integrated quantitative models:** a quantitative approach to estimate the consequences of different interventions on the environmental, economic and social systems, based on a series of assumptions and constraints related to the behaviour of the agent.
- **Computer simulation:** a quantitative approach to forecast the consequences of interventions at different temporal and spatial scales across environmental, economic and social systems.

This document discusses the trypanosomiasis problem and the challenge of assessing the direct and indirect impacts of the eradication campaign across environmental, economic and social systems. The document presents the available tools for impact assessment of T&T interventions to help project implementers to identify adequate options for assessing impacts of interventions based on their target level of analysis, available resources and constraints.

CHAPTER 1
INTRODUCTION

Trypanosomiasis is a disease caused by parasites (called trypanosomes) and transmitted by tsetse flies; it affects humans, livestock and wildlife. The disease is present in 37 African countries covering an area of over 10 million km^2 and affecting over 60 million people. Trypanosomiasis represents a severe constraint to the development of the infested areas and causes losses in the agricultural sector of sub-Saharan Africa estimated at about US$ 1.3 billion annually (ADF 2004a).

Previous efforts to control the disease largely focussed on reduction of the abundance and distribution of the vector. However, any gains made through these control efforts were short lived due to the resurgence of fly populations and disease prevalence in the controlled areas. Based on these experiences, the African Union (AU) is promoting the elimination of the tsetse flies to eradicate the disease from the continent through the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) with support from the African Development Bank (ADB) and other development agencies

Eradication has costs and benefits that need to be evaluated to estimate the viability of the investment and the sustainability of the interventions. Any interventions in tsetse control and eradication have environmental and socio-economic implications depending on the approach used and the place where the control is undertaken. Therefore the direct and indirect effects of the tsetse and trypanosomiasis (T&T) interventions should be evaluated across the natural, social and economic systems to properly estimate the costs and benefits of the eradication campaign.

These natural, economic and social systems are dynamic and complex thus they exhibit non-linear behaviour and spatial and temporal lags in their response to T&T interventions, making it difficult to estimate their direct impacts on an individual system. In addition, these systems are linked and interdependent. In consequence, interventions on the natural systems can have indirect effects on the economic sector and human society; in the same way interventions in the economy or society can have indirect effects on the natural environment. Understanding how natural, economic and social systems are interlinked and interdependent is necessary to identify the direction of the flows and the magnitude of indirect effects of T&T interventions to estimate with higher accuracy the costs and benefits of the eradication campaign, identify areas where further interventions are needed to avoid negative feedback and design strategies to mitigate adverse effects across systems.

Considering the complex nature of the involved systems, the way they are interlinked and their feedback mechanisms, assessing the impact assessment of T&T interventions is a complicated task. The challenge is to understand and quantify how the interventions directly affect the environmental, economic and social systems, and how the indirect effects of an intervention implemented on one system spreads through the others affecting their processes and modifying the flow and direction of the links between them. Such assessments require first a conceptual framework to help map out the main cause-and-effect relationships and response patterns. Secondly, the assessments need guidelines on how to gauge the impacts to target the right components or groups in the system, use the right methods and tools to quantify the effects and facilitate informed decisions.

In this report, we provide guidelines on methods and tools for conducting impact assessments of T&T interventions on the environmental, social and economic systems and on approaches for the integrated impact assessment of the interventions. The purpose of these guidelines is help donors, development agencies, project implementers and other T&T eradication stakeholders to identify adequate options for assessing the impacts of T&T interventions based on their target level of analysis, available resources and constraints.

1.1 The purpose of these guidelines

One of the needs identified by the scientific community during the World Summit on Sustainable Development is to make science more policy relevant by generating tools that have a common language that is understandable to all stakeholders. Some of the tools identified include:

- conceptual frameworks, which provide powerful insight and organizing qualities for sustainability analyses
- indicators and indices of development status and environmental change
- specific forms of analysis relying on indicators that are best selected through the use of sound conceptual frameworks
- Assessments that are carefully constructed and produced to provide policy inputs.

The purpose of these guidelines is to help target priorities and identify options to assess impacts of T&T interventions. Key to meeting project objectives is identifying the issues of highest concern; this is done before looking at the actions and responsibilities. Increasing focus and precision reduces the likelihood of being effective. It is not possible to effectively solve all the environmental problems concurrently without a logical approach to each one.

These guidelines are therefore aimed at helping PATTEC project managers and their experts target their priorities in environmental and socio-economic impact assessments. This will allow them to address pertinent issues adequately for the benefit of all stakeholders and allocate their resources rationally. Availability of a set of agreed upon guidelines for assessments could also serve as a proof that the assessments were done using the same procedures followed in other countries.

1.2 Types of impacts due to T&T interventions

Environmental and socio-economic impacts of T&T interventions fall into two broad categories based on their relationship to the primary actions of T&T interventions (Jordan, 1986):

1. Direct impacts—These are reactions in the environmental and socio-economic states that arise directly from the intervention activities, e.g. due to spraying or presence of odour baited traps in the field etc.
2. Indirect impacts—These are reactions in the environmental and socio-economic states that arise from activities (mainly anthropogenic) related to removal or reduction in trypanosomiasis challenge, e.g. human migrations or increase in livestock numbers etc.

Direct impacts vary with the type of interventions used and may also depend on the ecosystems in which the interventions were made and time or season they were made. Indirect impacts, however, are independent of the type of intervention used and its timing but will be dependent on the ecosystems on which the reactions are taking place. Direct impacts are mainly the effects of the intervention to non-target organisms (non-tsetse insects and biodiversity in general but the chain of reactions may extend to other levels of energy flow), people, water and air quality and the socio-economic implications for making the intervention. Indirect impacts result from the changes that come from increases in human activities manifested mainly through changes in land use, demography and socio-economics and the physical infrastructure like roads. Both direct and indirect impacts may have short- and long-term effects on the environment and socio-economics.

1.3 Challenges in assessing impacts of T&T interventions

In all classical assessments of impacts, there is a need to carefully select the methods to use so that the information generated is clear, understandable and useful to different stakeholders. The method must generate data that address the questions which lead to achieving the objectives for undertaking the interventions. In choosing methods for assessing the impacts of T&T interventions we are faced with the following challenges:

1. **Direct impacts are control techniques dependent**

   There are a number of options available that PATTEC country teams can choose from to suppress tsetse populations. These range from the odour baited traps and impregnated targets to chemical based sequential aerosol techniques (SAT) and ground spraying. Depending on the method selected, direct impacts may be different as the environmental and social components may be differentially affected. Consequently the data required to assess these impacts will vary depending on the method used. The challenge is to design an impact assessment approach that incorporates environmental and socio-economic components for specific control techniques.

2. Direct and indirect impacts are time scale dependent

The impacts of T&T interventions can be evident at different temporal scales. Appropriate designs of the assessment strategies should consider the expected magnitude of the changes in environmental and socio-economic systems to define the implementation activities in the temporal windows when the impacts are measurable.

3. Direct and indirect impacts are spatial scale dependent

The PATTEC projects, unlike the previous tsetse control operations, are embracing area wide approaches focusing on large areas of tsetse distribution. The biophysical and socio-economic characteristics of these areas might be different and therefore impact assessment and methodological approaches should be able to respond to the varying characteristics of the involved systems. The methodology must be designed and applied to capture the variability in system components and appropriate scale dependent tools must be used to assess the impacts on systems components.

4. Separating indirect impacts of T&T interventions from other driving forces

Inappropriately, T&T interventions are considered as the sole driving force to land use change in tsetse-freed areas. However, other drivers may contribute to changes in environmental and socio-economic systems in these areas. Disaggregating the impacts of T&T interventions by their driving forces is a major challenge. Baseline data and control sites help identify the direction and magnitude of different drivers promoting impacts in the different systems.

5. Evaluating impacts of interactions and coupled systems

Impacts in one system may be affected negatively by another system. Since these interactions may vary from place to place, it is important to understand their effects, especially if the results have to be compared between places or aggregated to larger spatial scales. To capture the coupling effects of the interactions between the environmental and social systems requires a methodology to integrate information from both systems. The challenge is to develop an interdisciplinary approach to assess the impacts such that data on all systems are comparable.

6. Generate knowledge and disseminate it to different stakeholders

Results of impact assessments need to be disseminated to various stakeholders including government officials, the scientific community, project managers, development agencies, the private sector and farmers. The challenge is to have the information in a format that can be useful to them considering their different needs.

These and other challenges for assessing the impacts of T&T interventions can be overcome using different methodologies. In this report, we discuss four broad categories of impact assessments: a) methods for assessing environmental impact, b) methods for assessing economic impacts, c) methods for assessing social impacts and d) methods for integrated analysis and scenario development. Each of these methods has tools for assessing the impacts across different spatial and temporal scales. For the environmental impact assessment the scales of analysis are hierarchical, going from organisms at plot level to communities at landscape level. For economic impact assessment the levels of analysis can range from assessing the effects of interventions at herd level to farm, regional, national and international scale. In terms of assessing the social impacts the scales range from household to community and society. Finally, the levels of analysis for integrated impact assessment and scenario analysis range from participatory methods to computer simulations. These tools can help define key measurable variables that can be used as indicators to track environmental, economic and social changes. In addition, these indicators can be used to evaluate the performance of the project in addressing the objectives.

This report presents an extensive review of the different methods and tools to assess the impact of T&T interventions at different scales of analysis. The structure of the document is as follows: in the next chapter we present concepts for integrated assessment; Chapters 4 to 6 outline methods for environmental, economic, social impact assessment, Chapter 7 presents decision support tools related to T&T interventions, while Chapter 8 outlines how to select tools for assessments. In the appendices we give detailed accounts of each tool including a rating of the requirements in terms of skills, time and financial costs. A list of techniques likely to be used at various stages in T&T interventions and the likely direct impacts on environment are given in Table 1.

Table 1: Summary of tsetse control and eradication techniques and their direct impacts on environment

T&T control and eradication techniques	Associated direct impacts on environment	Significance of the impacts	Available options to mitigate or minimize the impacts
Odour baited traps	Non-target insects caught in the traps	Acceptable	None
	Vegetation clearance along service paths/transects	Negligible	Paths should be narrow
Insecticide impregnated targets	Effects on non-target organisms	Acceptable	None
	Use of treated fabrics by un-informed people	Significant and unacceptable	Create public awareness
Treated nets for zero grazing	Killing of non-target organisms	Acceptable	None, but may be beneficial on other disease vectors
	Effect of chemicals on children	Significant and unacceptable	Keep children away from the net, especially when chemical is fresh
	Chemical contamination on milk	Significant and unacceptable	Avoid contacts with treated nets
Crush pens and live baits or moving targets	Spill of insecticides around the crush pen	Unacceptable	Fencing off areas used for crush pens
	Spread of insecticides to objects in contact with cattle	Unacceptable	Keeping treated cattle out of vegetable and fruit gardens and areas with other consumables
	Contamination of milk with chemicals	Significant and unacceptable	Proper sanitary conditions during milking
Ground spraying	Application of insecticides on vegetable crops and non-target organisms	Significant and unacceptable	Apply on tsetse habitats and during appropriate times and seasons
	Accumulation of chemicals in water reservoirs	Significant and unacceptable	Should not spray on small stagnant water bodies
	Effects on people handling spray pumps	Significant and unacceptable	Public education on proper use of insecticides
Pour-ons	Effects on non-target organisms	Acceptable	None
Sequential Aerosol technique (SAT)	Effects on non-target organisms	Acceptable	None
	Effects of chemicals on stagnant water reservoirs	Unacceptable	Public awareness
Sterile Insect Technique (SIT)	Effects of gamma radiated materials on environment?	Acceptable	Public awareness
Trypanocidal drugs	Disposal of drug containers	Acceptable	Public awareness of proper disposal methods

CHAPTER 2
IMPACT ASSESSMENT ISSUES FOR T&T INTERVENTIONS

2.1 Impact assessment: Concept and procedures for practitioners and agencies

Impact assessment determines how a given intervention affects the environment, individuals, households and institutions and whether the changes are attributable to the project, programme or policy intervention (World Bank 2004). These assessments can be ex ante or ex post. Ex ante assessment evaluates the impact of current and future interventions providing information on the likely environmental, economic and social impacts and how the flow of costs and benefits is distributed in the affected population. Ex post impact assessment evaluates the impact of past interventions measuring the benefits and costs of the interventions, evaluating the attainment of the objectives and providing information on the pathways through which observed impacts have occurred.

Practitioners need to perform a series of steps before the impact assessment exercise. These steps include:

- a description of the intervention with an account of the proposed activities and selected alternatives (including a 'do nothing' option)
- a screening process to determine whether the intervention is suited to assessment and at what level of detail the assessment should be done
- a scoping process to identify the key issues to be examined and the boundaries of the assessment.

Scoping considers possible significant impacts and defines further which issues need to be addressed by the assessment process.

Following these initial steps, you can plan the impact assessment. It involves a series of ordered actions:

1. Collect baseline data and conduct a baseline analysis of the bio-physical and socio-economic systems to understand the current situation.
2. Develop projected scenarios for the involved systems in conditions with and without the projected intervention.

3. Determine the impacts on the involved systems under the conditions of the projected interventions.
4. Evaluate the significance of the differences between the baseline and the projected outcomes, including the cumulative effects.
5. Develop means to avoid or mitigate potential adverse impacts and create or enhance positive ones during the lifetime of the action.

For the agencies involved in T&T interventions an ideal impact assessment group should perform many duties including:

- Technically review the assessment document provided by the practitioners to develop recommendations for the decision makers as to whether and under what conditions the proposed action should proceed.
- Manage the implementation of avoidance/mitigation and creation/enhancement measures to optimize action outcomes during the lifetime of the project.
- Supervise the data collection practices to ascertain that the monitoring activities comply with the agreed procedures.
- Audit and review the accuracy of the predicted impacts and mitigation measures.

2.2 The need of a counterfactual: Baseline data and control areas

Baseline data are required to generate a counterfactual, i.e. information on the status of the system before the intervention. This counterfactual is compared with the expected state of the system for ex ante assessment or with the impacts already seen for ex post assessments. The baseline data should include data on those sectors and variables that are expected to change after the intervention. In addition, the methods used to generate the baseline data should be similar to those that will be used in the assessment exercises so that the results can be comparable in determining the impacts.

When baseline data are not available, an alternative approach is to define areas where there have been no interventions and use them as control areas to compare the effects of interventions (treatments). However, this approach does not consider the differences between the systems and the fact that many other driver forces might be operating in the control and treatment areas making it difficult to quantify the changes in the system that are due to T&T interventions.

Use of before and after interventions data and treatment and control areas data in assessments of T&T intervention impacts is discussed in Swallow, 2000 and Shaw, 2003.

Figure 1 Counterfactual data collection plan

	Treatment Area (are with T&T interventions)	**Control Area (Area without T&T interventions)**
Before	Data is collected before T&T interventions	Data is collected in the control area before interventions in the treatment area
After	Data is collected in the T&T intervention area after the interventions are done	Data is collected in the control area after interventions have been done in the treatment area

Use of a control area (area without T&T interventions may assist the assessor to isolate changes occurring in the systems that may be due to external factors that are not related to T&T interventions.

2.3 Indicators: Selection criteria

The main reason for developing indicators is to measure, monitor and report progress towards a goal. Indicators allow us to better organize, synthesize and use information representing basic tools for facilitating public choices and supporting policy implementation. Although the ecological, social and economic systems are interdependent, researchers construct different indicators for each system. This is because combining economic, social and environmental variables in one indicator is undesirable because they are often in conflict with one another and a single indicator does not properly consider the interaction between different system components.

There are many potential indicators for each system and level of analysis but their relevance to project objectives is also different. There is therefore a need to follow certain criteria when deciding which indicator(s) to measure. The challenge in selecting indicators is to find measures that can meaningfully capture key changes, combining what is substantively relevant as a reflection of the desired result with what is practically realistic in terms of actually collecting and managing data. Thus, an indicator must be useful, have relevance for users, possess analytical soundness and be measurable. Remember that no one indicator will satisfy all criteria equally. Ultimately, the choice of indicator is determined through a holistic assessment of validity and practicality. The selection of indicators is an iterative process, building on consultations between programme managers, stakeholders and partners. The process of selecting an indicator takes several steps including brainstorming ideas, assessing each one and narrowing the list and, finally, making an indicator monitoring plan.

Several helpful questions for the selection of indicators based on specificity, measurability, attainability, relevance and traceability (SMART) criteria are presented in Box 1. Examples on how to apply SMART criteria in indicator selection are given in Boxes 2 and 3.

BOX 1 **The SMART way to select indicators (UNDP: RBM report on indicators:http://www.undp.org/eo/documents/methodology/rbm/Indicators-Paperl.doc)**

Specific:

- Is it clear exactly what is being measured? Has the appropriate level of disaggregation been specified?
- Does the indicator capture the essence of the desired result?
- Does it capture differences across areas and categories of people?
- Is the indicator specific enough to measure progress towards the result?

Measurable:

Are changes objectively verifiable?

- Will the indicator show desirable change?
- Is it a reliable and clear measure of results?
- Is it sensitive to changes in project implementation?

Do stakeholders agree on exactly what to measure?

Attainable:

- What changes are anticipated as a result of the intervention?
- Are the result(s) realistic? For this, a credible link between outputs and outcome is indispensable.

Relevant:

Does the indicator capture the essence of the desired result?

- Is it relevant to the intended outputs and outcome? To judge the relevance of indicators, the evaluator and project management may have to identify the target groups and their needs, expectations and criteria.
- Is the indicator plausibly associated with the sphere of activity?

Trackable:

Are evidences used traceable?

Are data actually available at reasonable cost and effort?

Are data sources known?

Does an indicator monitoring plan exist?

BOX 2 **The SMART way to select indicators: Soil fertility**

Specific:

There are specific parameters that are measured to determine soil fertility like soil nitrogen, potassium and phosphorus (NPK) and other soil nutrients. The indicator will show the nutrients available for plant growth in order to assess the need for fertilizer or manure input. Analysis of soil chemical composition across different land use types, soil types and land management practices will give variability in the amounts of these essential nutrients along these characteristics. The indicators are very specific and can be used to measure how variation in soil fertility affects crop production.

Measurable:

The indicators can be accurately determined through laboratory analysis and field observations. Changes in the indicator can be linked directly to plant health and crop performance. Results of soil fertility analysis are reliable and clear. The indicator is sensitive to changes in land use, land cover and land management, the attributes that will be affected by project implementation. Work done in the Environmental Management Component of the Farming in Tsetse Control Areas (FITCA-EMMC) shows that stakeholders agree on what to measure (Gachimbi and Maitima 2004a, 2004b).

Attainable:

As a result of the intervention soil fertility may have reduced due to nutrient mining or extraction by crops and leaching due to erosion in open fields. For this, a credible link exists between indicator measurements (outputs) and desired crop productivity (outcome). The results are realistic because they directly reflect the conditions of the outcome.

Relevant:

The indicator captures what is required to assess the changes and what is needed to design a mitigation measure/ scheme. The intended outputs and outcomes of T&T interventions include increased agricultural productivity and sustainable land utilization. The indicator is relevant in both respects and will address the needs and expectations of farmers and project implementers to reach their goals. Since T&T interventions are expected to lead to changes in land use, land cover and land management, the indicator is key in impact assessments.

Trackable:

This refers to whether data used in assessments are traceable. Data on soil fertility analysis can be obtained at reasonably low cost and effort. Data are collected from field samples in the project areas. Plans for monitoring changes in soil chemistry should be made before project implementation.

BOX 3 **The SMART way to select indicators: Years of education**

Specific:

The indicator captures the years of formal education of the head of the household. The level of dis-aggregation is defined in years and the indicator captures the differences in human capital that could be associated to different management practices in tsetse freed areas. The indicator captures differences across areas and categories of people, e.g. higher income groups are expected to have higher education levels, and can be used to measure progress toward a result such as increased income and investment in human capital

Measurable:

The changes in years of education are verifiable and the results are reliable and clearly measurable. The indicator is sensible to changes in project implementation and the stakeholders can agree to measure education in terms of years of school attendance.

Attainable:

The changes in the years of education as a result of the intervention can be anticipated and it is expected that as an area is cleared of tsetse and income increases, families can invest in education ensuring that the next generations have higher levels of education.

Relevant:

The indicator captures the essence of changes in productivity and income as a result of successful tsetse eradication and has positive impacts on human capital.

Trackable:

Are evidences used traceable?

Data on the current years of education of the head of the household are available at reasonable cost and the data sources are well known. The indicator is easy to monitor over time.

2.3.1 Examples of indicators for environmental and socio-economic baseline data and impact assessment

Baseline data are required for all parameters on which the assessment is to be made. These include biophysical and ecological conditions such as soil fertility, biodiversity composition and abundance, and socio-economic characteristics like household income, commodities produced, education and nutrition among others. It is from the baseline information that changes can be determined during future assessments. Baseline data should be collected before the interventions start. These data should be based on a set of acceptable indicators for each system or component of the assessment. To guide the development of baseline data it is therefore necessary to first develop a set of indicators to be used in assessing changes. As far as possible the methods used to generate the baseline data should be similar to those that will be used collect data for the assessment so that the results can be comparable in determining the impacts. The areas in which to develop baseline data and the indicators for each area of assessment are outlined in Table 2.

Table 2: Indicators for developing baseline data and assessing impacts

Criteria	Impact category	Indicator
Land use/land cover	Types and extent of land cover	1. Diversity and areas of land cover types
	Vegetation types structure and distribution	2. Ecosystem types and their abundances 3. Species composition 4. Species richness
	Land use types	5. Areas of land under different uses (e.g. cropped, grazing, settlements etc.)
Household income	Cash amounts	6. Household income
	Distribution between households	7. Variation of income between households
		8. Non-farm income sources
		9. Remittances
Changes in production	Crop production	10. Crop yields; Crop types; Farm inputs
	Land production units	11. Farm sizes
	Livestock production	12. Types and number of livestock per household
Impacts on social/ human welfare	Household structure	13. Household head; Composition; Occupation
		14. Number of people in the family
	Nutrition	15. Types of food consumed
	Community structure	16. Ethnic groups and migrations
	Gender	17. Age structure. Responsibilities among gender
Land tenure	Land ownership	18. Who owns the land (by age class, gender, and ethnic groups)
		19. Who has access to the land/user rights
Ecosystem functions and services	Species composition in different vegetation types	20. Species diversity index 21. Species richness
		22. Composition and abundance of medicinal and other plants of economic importance
		23. Abundance of plant and animal species of conservation interest
Soil characteristics	Changes on soil physical characteristics	24. Texture 25. Erosion potential 26. Moisture retention potential
	Changes on soil fertility	27. Micro- and macro-nutrients 28. Soil chemistry
	Soil biological indicators	29. Soil microbial species diversity 30. Soil respiration
Biodiversity	Effects on ecosystem diversity	31. Ecosystem fragmentation
	Effects on soil biodiversity	32. Number and types of soil organisms
	Effects on animal biodiversity	33. Number, types and distribution of wildlife
	Effects on commercial and ecologically beneficial insects, e.g. bees, butterflies, dung beetles etc.	34. Abundance of beneficial insects
Water resources	Water quality and quantity	35. Pollution levels in water resources 36. Availability of water to people, livestock and wildlife

2.4 Key questions for developing integrated impact analysis on trypanosomiasis interventions

The key questions for developing an integrated impact analysis on T&T interventions are presented here below; their relationships in the underlying systems are shown in Figure 1.

Impact of what

An initial issue is defining in general terms what is being analysed. There are many potential trypanosomiasis interventions in response to a broad set of environmental and socio-economic factors that trigger the need for control and eradication activities. Different interventions might have distinct objectives and scopes and differ in the methods used. Many of these interventions can go beyond disease related issues and be concerned with issues as diverse as poverty reduction, food security, equity or sustainability (e.g. AFDB 2004).

Impact on what

As was previously mentioned, both economic and social systems are linked and dependent of natural systems. Animal disease can generate a set of direct and indirect impacts on different systems with different magnitudes. The infection with trypanosomiasis negatively affects the number and productivity of animals and their capacity for traction. This may have implications on the agro-ecosystems by reducing the amount of cultivated land, manure availability and the quality of land preparation. These factors also have a negative effect on crop diversity, crop yields and farmer's income. However, the creation of trypanosomiasis free areas can increase the demand for cropland, generating rapid changes in land use and land cover with potential social impact because of the high immigration rate into these sites (e.g. Muriuki et. al. 2005). Hence it is necessary to define impact on what is being evaluated. Is the impact on the ecosystems, on the social or economic system or is an integrative impact assessment considering all of them?

Impact on whom

Trypanosomiasis interventions can have an impact on various groups. Depending on the project, affected or beneficiary groups can be defined in terms of livelihood, age, gender, income level, geographic area, ethnicity or other criteria (World Bank 2004). A correct definition of the target groups of the project is useful to define interventions, develop policies and understand potential impacts on other stakeholders. Defining the target groups helps demarcate the level at which the impacts will be analysed. There are several potential nested hierarchies for both socio-economic and environmental levels of analysis ranging from local to continental scales. Different approaches, methods and indicators can be appropriate and effective for a given level of analysis while others are less so or completely inappropriate (see Kamuanga 2003).

Impact how

Once the adequate environmental, social and economic levels of analysis have been defined and the target of T&T interventions have been identified, the next question is how the impacts of the intervention on the economic, social and natural systems occur. Figure 2 gives a diagrammatic representation on how impacts may result from interventions.

This understanding gives information on where to target to assessment of impacts. Researchers must select a set of appropriate methods that will measure changes in the right areas of the system where they occur, taking into account available human and financial capital, prevailing ecological and institutional circumstances and the objectives of the intervention. Choosing a method of analysis often involves a compromise between a method that is sufficiently detailed to capture the impacts on the system(s), and one that produces results that the policy makers will understand and be able to use. In addition, the method of analysis used will determine the data requirements. It is important to know the availability of data for each system and the availability of resources to collect additional data if they are missing or inadequate (see Rushton et al. 1999). Distinct methodologies can be used to answer different questions; different approaches have distinct limitations, provide different information and have distinct data requirements. They also differ in the time needed to complete the study and the required level of skill of the researchers to develop or apply the methodologies (World Bank 2004).

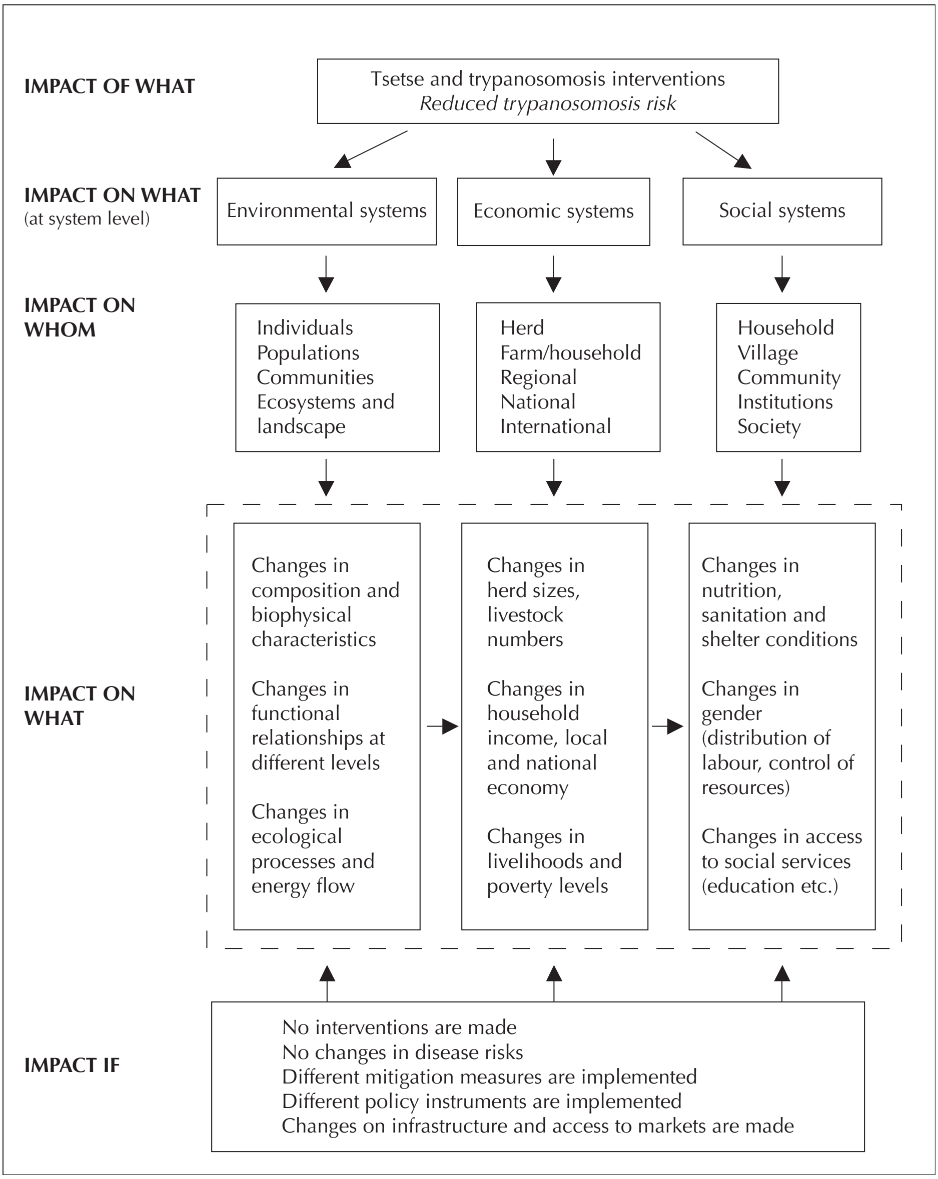
Impact if

To make informed decisions, public and private decision makers need accurate information about the impacts of alternative options including a do nothing option. Figure 2 below outlines the need for knowledge of the impacts if; no interventions are taken, no changes in diseases risks, different mitigation measures are implemented, different policy instruments are implemented, and changes on infrastructure and access to markets are made.

Based on the complexity of the involved systems, the links between them and the possibly competing objectives, there is a set of potential tradeoffs within and among systems. Identifying the tradeoffs associated with different alternatives and of different interventions is essential for designing programmes and monitoring impacts (Crissman et al. 1998). In this context, the translation of impacts in a common currency (e.g. monetary valuation of environmental impacts vs. the monetary value of the agricultural production) makes the tradeoffs more evident and facilitates the identification of data requirements.

A diagrammatic outline of how the key questions relate to the processes in the environmental, economic and social systems is presented in Figure 2.

Figure 2. Diagrammatic representation of the key questions in relation to systems.



2.5 Issues that impact assessments need to address

The African Development Bank conducted two strategic environmental and social assessments (SESA) in relation to the implementation of the PATTEC programmes (ADF 2004 (a) and (b). These two reports identified a number of issues that affect different sectors of the environment and the socio-economics of areas where the PATTEC projects are being implemented. The issues were categorized as direct impacts resulting from use of suppression techniques (Table 1) and indirect impacts resulting from changes in land use due to reduced risks of trypanosomiasis (Table 3).

Table 3: Matrix of impacts (ADF 2004(b)

Control measures	Activities	Potential adverse effects identified in SESA
Selective ground sprays and sequential aerial spraying (limited areas only)	Spraying with ultra-low volume aerosols	■ Health risks to users ■ Potential risks to children if storage unsecured ■ Pollution of soil and water bodies ■ Impacts of aquatic and terrestrial fauna, arthropods being most at risk
Livestock spraying	Pour-ons, dips and sprays	■ Health risks to users ■ Pollution of water bodies ■ Decreased level of resistance to tick borne diseases
Traps and targets	Deployment of chemical-impregnated and odour-baited traps and targets	■ Health risks to users during impregnation ■ Limited health risk from skin contact during deployment ■ Same potential environmental impacts as for other insecticide-based methods but risk level is very limited
SIT	Production and release of sterile tsetse fly males	Exposure of facility operators to radiation or environmental contamination
Eradication of tsetse fly	Use of all control methods in an integrate way to eradicate tsetse flies	■ Overgrazing ■ Intensification of agricultural production leading to pollution and soil erosion ■ Desertification ■ Encroachment of livestock in national parks ■ Change in settlement patterns: conflicts between agriculturalists and pastoralists ■ Gender conflicts as women may have more work if cultivated area increases

2.5.1 Potential impacts due to changes in land use

The SESA reports indicate that the programme will have indirect impacts resulting from the changes in land use, in particular, from the reclamation of land for agricultural and animal production as new areas are cleared of tsetse and trypanosomiasis. This section presents the positive and negative impacts identified in SESA.

Positive impacts

The crucial positive impacts of a T&T eradication programme are in terms of economic and social development. The opportunity tsetse eradication offers for changes in land uses is one of its key benefits. Tsetse freed areas will not only become more favourable for livestock rearing and the use of more productive breeds but also for agricultural production. The increase in livestock will provide opportunities for increase in land acreage for crop production due to the availability of animal traction. As human health improves, the number of working hours increases and, consequently, the cultivated areas and productivity may also increase. The intensification of the two activities, livestock and agriculture, will increase the potential for integration and the development of mixed farming systems. The increased use of manure as fertiliser, for instance, is a practice that has recognised environmental benefits.

Tsetse control may also offer opportunities to redress income inequalities between different groups. Increased milk production, besides contributing to better child nutrition, provides a source of income to women. Other groups that may derive benefits from tsetse control include inland fishermen who will have access to rivers/streams all times of the day without fear of tsetse and trypanosomiasis. Others may benefit from increased tourism potential of the riverine tsetse-free areas.

Clearing tsetse from relatively inhabited areas offers the opportunity for careful land planning in areas that may otherwise have been, regardless of tsetse control, reclaimed and degraded. In Ethiopia, for example, extensive lowland areas are the property of the state. As a result, the state has some degree of control over land use and can promote the implementation of sustainable farming systems. In addition, eradication of tsetse from one area will reduce the pressure on naturally tsetse free areas, which will translate in environmental benefits.

Negative impacts

Negative impacts are likely to be more noticeable when tsetse fly is eradicated from areas that are presently unoccupied. In these areas, the eradication of the fly may facilitate radical changes on the landscape. Clearing land for agriculture and using timber for construction and domestic uses may for instance lead to soil erosion. In many countries land use changes that may arise from tsetse eradication will not be in terms of occupation of new lands but in intensification of production in the cleared areas. In such a situation, eradication of the fly offers the opportunity for livestock rearing which, if unregulated, may increase the risk of overstocking and overgrazing.

Negative impacts may also derive from conflicts due to unequal distribution of benefits or from conflicts between different groups trying to clear access land. Unequal distribution of programme benefits between genders may also be an issue. The clearance of tsetse will increase the area available for crop production which may increase the workload of women who are responsible for sowing and weeding. However, ploughing, which is mainly a task performed by men, will be facilitated by the availability of animal traction. These guidelines present tools for use in assessing the impacts identified in the SESA.

CHAPTER 3
APPLYING THE GUIDELINES IN IMPACT ASSESSMENTS

3.2 Data collection

In impact assessment studies the way data are collected can determine how it could be analysed and hence the results that can be achieved. There are three basic types of approaches (Shiferaw et. al., 2005; Thrustfield, 2005; Leung, 2001 and Krebs, 1998). : 1) methods that collect data on the entire population or land area; 2) methods that use a statistically representative sample of the population (that is with random from a formal sampling frame), such that distribution of characteristics through the larger population is reliably represented; and 3) methods that use purposive sampling, which characterize the sampled population but do not provide statistical estimates for the larger population.

3.2.1 Reasons for data collection

To develop an understanding of how a project is performing in various fields of its implementation, it is necessary to obtain data in each of the fields the project is expected to influence. Data are required in each of the fields before the project is implemented to provide baseline information from which any change due to the interventions of the project can be deciphered. It is therefore necessary to collect data that describe the situation that the project seeks to change or influence. On environmental impacts of T&T interventions for example, the primary concern is to understand the impacts of control technologies on non-target organisms or on biodiversity in general. For these assessments to show impacts on biodiversity, it is necessary to collect data on all or some representative members of the biodiversity in the affected area that are likely to be affected by the control techniques proposed for use by the project.

3.2.2 Sample size

Sample size is influenced by several factors such as the spatial extent, e.g. village, province, district or national; hypothesis being tested; and the level of statistical significance required. There are well known formulas for determining sample size taking these factors into consideration (see Kerbs 1998 and Shiferaw et al. 2005)

Ideally pilot surveys are done to capture the variability of the population which can be used to determine the appropriate sample size for the full survey. However, in many cases pilot surveys are rare due to constraints of cost and time. One rough and ready rule is to look at 20–30 respondents for each of the major factors considered in the study. For example, if a key aspect of the research is to compare male and female then the research should look at 30 males and 30 females in the responses. This number then needs modifying by the anticipated response rate to determine the target sample size. Another method that is commonly used is to estimate sample size based on results of previous studies which give an estimate of variability within a population. The following are two methods of determining sample sizes by percentage and by means.

3.2.3 Calculating a sample size

A frequently asked question is "How many households or animals should I sample. It is an extremely good question, although unfortunately there is no single answer! In general, the larger the sample size, the more closely your sample data will match that from the population? However in practice, you need to work out how many responses will give you sufficient precision at an affordable cost. Calculation of an appropriate sample size depends upon a number of factors unique to each survey and it is up to assessor to make the decision regarding these factors. The three most important are:

How accurate you wish to be?

How confident you are in the results?

What budget you have available?

The temptation is to say all should be as high as possible. The problem is that an increase in either accuracy or confidence (or both) will always require a larger sample and higher budget. Therefore a compromise must be reached and one must work out the degree of inaccuracy and confidence acceptable in the assessment. There are two types of figures that you may wish to estimate in your analysis: the mean value, and the percentage value.

For a mean

The required formula is: $\mathbf{s = (z / e)^2}$

Where:

s = the sample size

z = a number relating to the degree of confidence you wish to have in the result. 95% confidence* is most frequently used and accepted. The value of 'z' should be 2.58 for 99% confidence, 1.96 for 95% confidence, 1.64 for 90% confidence and 1.28 for 80% confidence.

e = the error you are prepared to accept, measured as a proportion of the standard deviation (accuracy)

For example, imagine we are estimating the mean number of livestock infected with trypanosomiasis, and wish to know what sample size to aim for in order that we can be 95% confident in the result. Assuming that we are prepared to accept an error of 10% of the population standard deviation (from the standard deviation of trypanosomiasis prevalence in a previous study we might be prepared to accept an error (10%), we would do the following calculation:

$$\mathbf{s = (1.96 / 0.1)^2}$$

Therefore **s = 384.16**

In other words, 385 animals would need to be sampled to meet our criterion.

Because we interviewed a sample and not the whole population (if we had done this we could be 100% confident in our results), we have to be prepared to be less confident and because we based our sample size calculation on the 95% confidence level, we can be confident that amongst the whole population there is a 95% chance that the mean is inside our acceptable error limit. There is of course a 5% chance that the measure is outside this limit. If we wanted to be more confident, we would base our sample size calculation on a 99% confidence level and if we were prepared to accept a lower level of confidence, we would base our calculation on the 90% confidence level.`

For a percentage

Although we are doing the same thing here, the formula is different:

$$\mathbf{s = \frac{z^2(p(1-p)}{e^2}}$$

Where:

s = the sample size

z = the number relating to the degree of confidence you wish to have in the result

p = an estimate of the proportion of people falling into the group in which you are interested in the population

e = the proportion of error we are prepared to accept

As an example, imagine we are attempting to assess the percentage of people using animal manure on their farms. If we assume that we wish to be 90% confident of the result i.e. z = 1.64 and that we will allow for errors in the region of +/-5% i.e. e = 0.05. But in terms of an estimate of the proportion of the population (p), if a previous survey had been carried out, we could use the percentage from that survey as an estimate? However, if this were the first survey, we would assume that 50% (i.e. p = 0.05) of farmers would use manure in their farms and 50% would not. Choosing 50% will provide the most conservative estimate of sample size. If the true percentage were 10%, we will still have an accurate estimate; we will simply have sampled more farms than was absolutely necessary. The reverse situation, not having enough data to make reliable estimates, is much less desirable.

In the example:

$$\mathbf{s = \frac{1.64^2(0.5*0.5)}{0.05^2}}$$

Therefore **s = 268.96**

3.2.4 Types of data

Data can be divided into two classes (Shiferaw et al., 2005; Thrustfield, 2005): (i) quantitative and qualitative and (ii) longitudinal and cross-sectional. Qualitative data is not numerical, e.g. race, gender, presence or absence, health and social indices etc. Quantitative data is data that have a numerical value. Data are therefore ‘quantitative’ if they are in numerical form and ‘qualitative’ if they are not. Note that qualitative data could be much more than just words or text. Photographs, videos, sound recordings and so on, can be considered qualitative data. Quantitative data is based upon qualitative judgments and all qualitative data can be described and manipulated numerically. In addition, quantitative data can be divided into discrete and continuous data.

Data which describe intrinsic properties of a system are unlikely to change with time. Other data are valid for short time periods, and yet other data may vary according to the type of assessment or as new knowledge becomes available.

Cross-sectional and longitudinal data collection approaches and their pros and cons are described in Table 4.

Table 4: Pros and cons for data obtained in different survey methods

	PROS	CONS
Cross-sectional: Conduct survey only once	Get impact information more quickly. Survey and analysis are less expensive with only one data collection round.	Aim is to understand change over time; cross-sectional study gives information about only one point in time.
Longitudinal: Conduct same survey at least two times: T1, baseline; T2, follow up. Trend: different people in T1 and T2. Panel: same people in T1 and T2	Opportunity to look at change over time, which is what one wants to evaluate.	Requires several years before impact results available. More expensive and more complicated to analyse. Need larger samples to compare results from two surveys.

3.2.5 Selecting survey and data collection approaches

There are two basic approaches in data collection (von Braun and Detlev, 1993; Casley and Kumar, 1992): one is conducting a complete census and the other is conducting a survey in a sample of the population or area under study.

Census

A census refers to data collection about every unit in a group or population. If you collected data from every household in the village, that would be regarded as a village census. There are various reasons why a census may or may not be chosen as the method of data collection. The advantages, disadvantages and tools of census data collection are presented in Table 5.

Table 5: Advantages and disadvantages of census data

CENSUS DATA
ADVANTAGES **Sampling variance is zero:** There is no sampling variability attributed to the statistic because it is calculated using data from the entire population. **Detail:** Detailed information about small sub-groups of the population can be made available.
DISADVANTAGES **Cost:** In terms of money, conducting a census for a large population can be very expensive. **Time:** A census generally takes longer to conduct than a sample survey. **Response burden:** Information needs to be received from every member of the target population. **Control:** A census of a large population is such a huge undertaking that it makes it difficult to keep every single operation under the same level of scrutiny and control.
TOOLS Tools for data collection at this level include among others: ■ Population census ■ Remote sensing ■ Resource inventories and mapping

Sample survey

In a sample survey, only part of the total population is considered for data collection (Poante, 1993; Casley and Kumar, 1992). The advantages and disadvantages of sample survey are presented in Table 6.

Table 6: Advantages and disadvantages of sample survey

SAMPLE SURVEY
ADVANTAGES **Cost:** A sample survey costs less than a census because data are collected from only part of a group. **Time:** Results are obtained far more quickly for a sample survey, than for a census. Fewer units are contacted and less data need to be processed. **Response burden:** Fewer people have to respond in the sample. **Control:** The smaller scale of this operation allows for better monitoring and quality control.
DISADVANTAGES **Sampling variance is non-zero:** The data may not be as precise as that from a census because the data are from a sample of a population, instead of the total population. **Detail:** The sample may not be large enough to produce information about small population sub-groups or small geographical areas.

3.2.6 Sampling design

There are two main categories of sampling design: probability-based designs, and judgement-based designs (Casley and Kumar, 1992; von Braun and Detlev, 1993). Probability-based sampling design applies sampling theory and involves random selection of sampling units. An essential feature of probability-based design is that each member of the population from which the sample was selected has a known probability of selection. When a probability-based design is used, statistical inferences may be made about the sampled population from the data obtained from the sampling units. Judgemental sampling designs involve selection of sampling units on the basis of expert knowledge or professional judgement (Table 7).

Table 7: Probability-based versus judgement-based sampling designs

	Probability-based	Judgement-based
Advantages	■ Provides ability to calculate uncertainty associated with estimates ■ Provides reproducible results within uncertainty limits ■ Provides ability to make statistical inferences ■ Can handle decision era criteria	■ Can be less expensive than probabilistic designs. ■ Can be very efficient with the knowledge of the site ■ Easy to implement
Disadvantages	■ Random locations may be difficult to locate ■ An optimal design depends on an accurate conceptual model	■ Depends upon expert knowledge ■ Cannot reliably evaluate precision of estimates ■ Depends on personal judgement to interpret adapt relative to study objectives

A complete sampling design indicates a justification for the selected approach and defines the number of samples and the time for collection. Some of the common sampling designs are given in Table 8.

Table 8: Types of sampling designs

Sampling design	Description
Judgmental sampling	Sampling units selected based on expert judgement
Simple random sampling	Sampling units selected using random numbers and all possible selections of a given number of units are equally possible.
Stratified random sampling	Target population is separated in a non-overlapping strata or sub-populations that are known or thought to be homogenous such that there is less variation among the sample units in the same stratum than among sampling units in different strata.
Cluster random sampling	Adaptive sampling is taken using simple random sampling, and additional samples are taken at locations where measurements exceed some threshold value. Several additional rounds of sampling and analysis may be needed. Adaptive cluster sampling tracks the selection probabilities for later phases of sampling so that an unbiased estimate of the population mean can be calculated despite over sampling of certain areas. An example application of adaptive cluster sampling is delineating the borders of a plume of contamination.
Systematic and grid sampling	Samples are taken at regularly spaced intervals over space (grid) or time (systematic). A starting point is selected randomly and then the remaining locations are defined at regular intervals over an area or time.
Ranked set sampling	Sets of field locations are identified using simple random sampling. The locations are ranked independently within each set using professional judgment or inexpensive, fast or surrogate measurements. One sampling unit from each set is then selected (based on observed ranks) for subsequent measurement using a more accurate and reliable method. Ranked sampling is an innovative sampling design that can be highly useful and cost effective in obtaining better estimates of mean concentration levels in soil and other environmental media by explicitly incorporating the professional judgment of a field investigator to pick specific sampling locations in the field.
Composite sampling	Materials from several of the selected sampling units are physically combined and mixed in an effort to form a single homogeneous sample, which is then analysed. Compositing can be very cost effective because it reduces the number of analyses needed. Compositing is often used in conjunction with other sampling designs when the goal is to estimate the population mean and when information on spatial or temporal variability is not needed. It can also be used to estimate the prevalence of a rare trait.

3.2.7 Methods of data collection

There are many methods commonly used for data collection (Krebs, 1998; Abramson and Abramson, 1999; Bowling, 1997). Examples of methods for collecting environmental data include wildlife census, biophysical surveys, remote sensing, resource inventories and mapping. Examples of methods for socio-economic data can include population census, group surveys, panel or multi-period cross-sectional survey, key informants and participatory rural appraisal.

Environmental and social surveys are commonly used to assess the impacts of T&T interventions. These surveys involve directly collecting information from people (or sometimes organizations) that the project is interested in. Well designed questionnaires are highly structured to allow the same types of information to be collected from a large number of people in the same way and for data to be analysed quantitatively and systematically. Questionnaires are best used to collect factual data and appropriate questionnaire design is essential to ensure that we obtain valid responses to our questions.

3.2.7 Selecting a survey approach

A systematic selection process is critical if reliable, relevant and cost effective data are to be collected. The appropriateness of any of the above discussed methods of data collection depends on the scope of the analysis, characteristics of the data, logistical factors and user needs. Other factors may include long-term potential for use of the data, frequency and period of data collection, financial and human resource requirements.

Before conducting the surveys it is necessary to consider detailed aspects of survey methods, sample size, selection of location; data collection techniques; enumeration requirements and existing skills; and seasonal or other timing considerations. These factors combine to determine the accuracy, precision and timing of the results. If these do not meet the survey objectives then either the objectives must be reviewed or the planning process repeated in an interactive manner until a satisfactory approach is determined.

3.3.9 Questionnaire design

A common procedure in designing a questionnaire involves the following steps (Dorman et. al., 1994; Roche, 1999):

1. Decide the information required.
2. Define the target respondents.
3. Choose the method(s) of reaching your target respondents.
4. Decide on question content.

5. Develop the question wording.
6. Put questions into a meaningful order and format.
7. Check the length of the questionnaire.
8. Pre-test the questionnaire.
9. Develop the final survey form.

The responses can be in open or closed formats (Bissett, 1994). In an open ended question, the respondents can formulate their own answers. In closed format, respondents are forced to choose between several given options. The advantages of each of these formats are shown in Box 4. It is possible to use a mixture of the two formats, e.g. give a list of options, with the final option of 'other' followed by a space for respondents to fill in other alternatives.

There are a variety of questionnaires for collecting data on environmental and socio-economic issues. The design of questionnaires has been extensively studied. The following references may be helpful in designing questionnaires to assess the impacts of T&T interventions; Abramson J and Abramson Z 1999; Bissett 1994; Bowling 1997; Von Braun and Detlev 1993; Casley and Kumar 1992; Dorman et al 1997; Krebs 1998; Leung 2001; Poate and Daplyn 1993; Roche 1999; Shiferaw et al 2005.

BOX 4 **Advantages of open or closed format**

Open format

- Allows exploration of the range of possible themes arising from an issue
- Can be used even if a comprehensive range of alternative choices cannot be compiled

Closed—that is, forced choice—format

- Easy and quick to fill in
- Minimise discrimination against the less literate (in self administered questionnaire) or the less articulate (in interview questionnaire)
- Easy to code, record and analyse results quantitatively
- Easy to report results

CHAPTER 4
METHODS FOR ENVIRONMENTAL IMPACT ASSESSMENTS

Environmental impacts due to T&T interventions have been a major concern in the past. The methods for estimating environmental impacts use different tools to assess the impacts of the interventions at different hierarchical levels. These levels are:

- Individual: Impacts of interventions on different organisms (target and non-target)
- Population: Impacts of interventions on changes in abundance and distribution of individuals
- Communities: Impacts of interventions on changes in species composition and structure in a defined area
- Ecosystems: Impacts of interventions on changes on biotic and abiotic processes and functions
- Landscapes: Impacts of interventions on changes in biotic and abiotic processes across ecosystems.

This chapter presents different methods and their tools to assess the impacts at different levels of analysis.

4.1 Methods for assessing the impacts of T&T interventions at individual level

To assess the impacts at this level a series of tools can be used.

4.1.1 Counting

Observing the ground and examining trap catches to quantify non-tsetse organisms caught or killed during interventions helps determine which other organisms are affected by the interventions. This assessment requires examining the insects in the traps and separating them from tsetse to determine their species and counting them.

Ground observations along the spray paths after spraying gives an idea of the insects/animals that have been killed by the intervention. Although some of the organisms may fall some distance away from the spraying area such an assessment will give a good representation of the affected organisms. The use of chemicals in T&T interventions is mostly restricted to application to animals in crush pens, spraying on animals (live baits), pour-ons, treated nets, and the recent sequential aerosol technique (SAT) which is reported to have very low chemical concentrations. Pitfall traps are a good technique for collecting data on the relative abundance of a wide range of surface invertebrates. These traps are used mainly for ground dwelling invertebrates like beetles. The traps are placed in a grid within the study area; they have killing and preservation agents in them. For further reading see Adis, 1979 and Wathern, 1986.

4.1.2 Scoping

After an intervention, the quickest method to assess the effects on organisms is to take a random walk through the area of intervention, observe and record any organisms that appear affected by the intervention. These could be organisms that are dead, misplaced from their normal habitats, look unconscious or those whose behaviour has changed. Such an assessment may be required, especially where insecticides are used either in spraying as a T&T intervention or in treated screens or nets. The assessment gives qualitative information on the spatial extent of the impact and develops a checklist of candidate organisms for further analysis. This is a relatively inexpensive method and does not require a specialist. The assessment can be used to determine studies that require involvement of a specialist. For further reading see Kent and Cooker, 1992. Wathern, 1986.

4.1.3 Chemical toxicity analysis

Toxicity tests provide a direct measure of the bioavailability to toxicants and, when combined with chemical analyses and field surveys, can help establish links between site contamination and adverse ecological effects. Toxicity tests evaluate acute, sub-chronic and chronic exposures and measure biological endpoints such as mortality, reproductive performance, growth and behavioural changes. Numerous toxicity tests can be adapted for field use to evaluate the exposure of test organisms. Toxicity tests may be used in both aquatic and terrestrial habitats. Traditionally toxicity tests involve single species and measure endpoints such as mortality, growth and reproduction. Many types of organisms are used in toxicity testing, including vertebrates (rodents, fish and birds), invertebrates (plankton, amphipods and insects), microbes and plants. Environmental matrices that can be tested include water, sediment and soil.

Field surveys of terrestrial and aquatic habitats can complement chemical analysis and toxicity testing, and may decrease the uncertainty in the assessment process by providing direct measures of impacts on site biota. Field surveys of contaminated sites provide information about the extent and patterns of contamination, and may help to identify sites to sample for chemical analysis. For further reading see Linthurst et. al. 1995 and Sheehan et. al. 1984.

4.2 Methods for assessing the impacts of T&T interventions at population level

4.2.1 Transects

There are two categories of transects: line transects and belt transects. The length of a transect depends on the nature of the habitat in the area and the extent of the area to be studied. Line transects may range from 100 m to 200 m or more. The more varied the habitat is the longer the transect to cover all the underlying habitats. Observations along the transect are made to determine presence or absence of the organism being studied. If present, the number of such organisms is recorded and the distances between the observations can give a statistical inference on the distribution of the organisms. This method is useful to determine distribution of plant species in a habitat. Sampling along the transects can be stratified to conform with habitat variability.

Belt transects are laid in much the same way as line transects but spread out in form of a belt of a certain width (usually 20 m wide but may vary depending on habitat structure and the individual organism being studied); the length could be 100 m. This method gives an advantage of area under which the distribution of individuals in a population can be expressed. This method is useful for analysis of abundance of ground dwelling organisms by estimating the number of burrows or mounts in a given area (area of the belt transect). For further reading see Ken and Cooker, 1992; Maitima and Olson, 2001.

4.2.2 Trapping

Trapping methods are used to capture individual or groups of organisms in a given habitat. Captured individuals are identified, studied depending on the objectives of the study and then released back into the wild. This method is used to study small mammals like rodents. Traps are made depending on the organisms being studied and sometimes baits (food or other attractants) are used to attract the organisms. Trapping tsetse flies using odour baits is an example of a trapping technique. Data obtained through this method can provide both qualitative and quantitative assessments of the abundance of small mammals and ground dwelling organisms. For further reading see Adis, 1979; Hill, et. al. 1995 and Magurran 1988.

4.2.3 Capture, mark, release and recapture

Capture or sample an organism using a regular method of sampling individual organisms, mark and release it to its normal habitat (usually the place of capture). After some time sample the same population and determine the number of marked individuals recaptured. This method is used to estimate the absolute density of a population. The method of marking should not reduce the organism's chances of survival, cause other members of the population to discriminate against it or make it an easier target for predators. For further reading see Andrewartha, 1970 and Southwood 1978.

4.3 Methods for assessing the impacts of T&T interventions at community level

4.3.1 Fogging

Analysis of impacts on arboreal invertebrates is done by fogging the selected trees and collecting the invertebrates that fall on a sheet of plastic paper beneath the canopy. The method is used to analyse the effects of aerial or ground spraying of insecticides on arboreal invertebrates. Fogging is done on the branches of trees or bushes using an insecticide. The method is used to estimate the abundance and species composition of arboreal dwellers. The plastic sheets give a good guide to fauna suffering from acute effects of the insecticide application. Studies have shown that fogging gives better results than shaking trees to collect arthropods. For further reading see Grant 1989 and Lambert et. al. 1991. Douthwaite, 1986; Douthwaite et. al. 1988.

4.3.2 Sweep netting

Sweep nets are used to trap a wide range of vegetation dwelling fauna. The nets are used to sample insect populations, especially in grasslands. The method uses a net that has a metal ring on one end and narrows on the other end. The narrow end of the net is closed to trap insects when a sweep is done through the grass. This method gives a quantitative assessment of insect fauna either dwelling or visiting the grass vegetation. The method can be used ex ante to develop baseline data or ex post to assess the impacts. Insects collected are identified and counts of the number of each group can be used to calculate the apparent densities of the different species in the grass. For further reading see Andrewartha, 1970 and Southwood 1978.

4.3.3 Quadrats

Quadrat sampling is used to estimate the composition abundance of plant species in a specific area or habitat. A conventional square quadrat usually has a wood or metal frame subdivided into equal lengths (usually 10 but sometimes 2 or 4) with strings or wires to form a grid with sizes varying depending on the type of vegetation being measured (Maitima and Olson 2001, Kent and cooker, 1992). This increases the accuracy in estimating the percentage cover of species, since it makes it possible to examine each sub-unit of the quadrat separately; the smaller size of the sub-unit increases the accuracy of the estimation.

Per cent cover within the sub-units is summed up to determine the coverage for the entire quadrat.

In each quadrat all species present are identified and recorded in a vegetation field data sheet. On the same data sheet, a tally of the occurrence of individual plants of the same species can be made to determine the total number of plants per species. Vegetation studies using quadrats will provide data on the counts of individual plants of every species found in the quadrat. Visual examination of the proportion of space covered by each species expressed as a percentage of the total area of the quadrat helps estimate the canopy cover by a species. For further reading see Maitima and Olson 2001; and Kent and Cooker 1992.

4.3.4 Transects at community level

Transects can be used to determine plant species composition in different ecosystems (see also Section 4.2.1). The most commonly used method is the transect and quadrat analysis. The quadrat may be either a square or circular area on the ground set to a certain size depending on the vegetation category understudy; the most commonly used quadrat type is square (see also Section 4.3.3).

Changes in vegetation structure can be measured in a number of ways. The standard method is the use of a line transect where names are used to identify and enumerate plant types and their specific locations along the line transect. Each plant identified in the transect is assigned to its life form (i.e. either herbaceous, shrub or tree based on its growth form) and its height is recorded. Each canopy cover should be estimated as a percentage within its own category (i.e. tree, shrub and herbaceous canopies separately and each as a percentage of the space occupied within its own strata). This method can be used to show relative changes in the distribution of vegetation types along a transect that is a representative of a vegetation type. The simplest way is to walk along the transect and determine the structural changes of canopy covers of each of the three strata expressing them in relative percentage. Changes in vegetation structure can be analysed from time series satellite imagery and air photos by calculating changes in total area cover under different canopies in a given space and over a given time. However, this requires high resolution satellite images or more preferably air photos. The main idea is to use a data source that can distinctively show the stratification of different canopies even in cases where the herbaceous, shrub and tree canopies exist together.

At community level transects are also used to analyse impacts on animal diversity. Belt transects surveyed on the ground, by vehicle or by aeroplane, for large animals (wildlife) in national parks or extensive rangelands give estimates of the types and numbers of animals present and their distribution. For further reading see Maitima and Olson 2001; and Kent and Cooker 1992.

4.3.5 Time series species count

The most commonly used method to estimate bird species number and composition in an area is the timed species count (TSC). This technique can be used to compare the bird fauna across a series of sites.

A TSC consists simply of a species list in which all species positively identified are listed, in the order of observation. Bird counts are made within a period of one hour. Ensure that all counts are made within the same time lengths to enable comparison between sites.

To make the count, one moves slowly around the study site, listing any species which are anywhere within it, regardless of how far away. Species flying over are included if they are using the site, for instance swallows feeding, kites looking for food or raptors displaying. Vegetation on which birds are found should be noted according to the classes provided.

Repeat sampling at the same site at different times of the day and during different seasons is usually done to reduce bias on the types of birds counted. For further reading see Pomeroy 199; Pomeroy and Tengecho 1986 (a) and (b).

4.3.6 Stratigraphic correlation

To show temporal changes at community level, short sediment cores can be raised from appropriate sites. Analysis of the remains of vegetation, soil organisms and certain aquatic or wetland organisms can show differences in species composition and abundance over tine. This analysis can show variations in temporal assemblages of organisms (biostratigraphic) which can be compared with temporal periods of interventions to analyse impacts on individual species at population level, communities and even ecosystems where abiotic factors contribute to the changes. For further reading see Maitima 1997 and Miall 1984.

4.4 Methods for assessing the impacts of T&T interventions at ecosystem level

4.4.1 Analysis of chemical pollution risks

An ecological risks assessment can be done to determine the information necessary to identify the potential hazards and the relative risks associated with the chemical and to facilitate management of the risks to best protect social, cultural, political and economic benefits associated with the areas. It is an approach to guide the process of evaluating chemically contaminated areas.

Ecological risk assessment (ERA) is a structured approach with four components that provide a systematic method to assess the effects of chemical contaminants on ecosystems. The four components are:

- Problem formulation: To identify and describe the ecological damage and resources potentially at risk from the use of the chemical and the manner in which the chemical will be applied.
- Exposure assessment: To describe the magnitude, duration, frequency and routes of contaminant exposure to potential receptors.
- Ecological effects assessment: To identify the nature of the hazards associated with the contaminant(s) and to quantify the relationship between exposure stress and receptor characteristics.
- Risk characterization: To integrate the exposure and hazard information by estimating the likely incidence of an effect under the conditions described.

Identification and characterization of chemical stressors determines the most likely pathway of movement of the contaminants through the ecosystem to help guide the sampling process. Chemical characteristics sometimes help predict a contaminant's fate and transport and its temporal and spatial movement through the site media. Knowing where the chemical is most likely to be compartmentalized and whether it is likely to bio-accumulate in biota helps to determine the most appropriate sampling and analysis methods. No single type of test can provide all the information necessary to determine the extent and magnitude of environmental contamination. Several types of test should therefore be used. Test methods include field surveys, chemical analysis of media samples, toxicity tests and bio-accumulation studies. For further reading see Lithurst et.al. 1995 and Sheehan et. al. 1984.

4.4.2 Environmental participatory rural appraisal (PRA)

Participatory rural appraisal (PRA) is a tool used to assess a number of impacts. At the individual level, this method can assess presence/absence or changing abundance of animal and plant species in a given area. At the ecosystem and landscape levels it can be used to assess changes or impacts on the extent and structure of ecosystems like forests, thickets, swamps etc. The method can also be used to assess impacts on ecosystem services.

This method uses knowledge from local communities and key informants who have been in the place for some time covering the period before and after the intervention. The method uses questionnaires, group interviews and discussions to answer key questions that aim at evaluating the impacts. Information generated can be qualitative and quantitative depending on the design of the assessment.

Stakeholder informants such as bee keepers and herbalists (people who use wild plants for medicinal purposes) could be a good source of information on changing wild plant species in an area because they are dependent on wild sources of pollen and medicinal herbs respectively. For further reading see Maitima and Olson 2001.

4.4.3 Soil analysis

Changes in soil characteristics as a result of changes in land use can be analysed to show impacts on the physical and chemical characteristics. These characteristics are important for sustaining crop productivity and conserving the environment. There a number of variables to be assessed in both the physical and chemical parameters. This analysis will give information on impacts on soil fertility to determine whether activities arising from the intervention are reducing the potential of land to support cultivation of crops. Assessment of soil fertility gives data in form of measurements of the amounts present per unit volume of soil of selected chemicals that determine soil performance in support of plant growth. The amounts obtained can then be used to determine whether it is beyond or below thresholds to support different crops. There are standard chemical analytical kits available from laboratory equipment suppliers, some of which are portable and can be used in the field. Analysis of plant growth can also give indications of soil chemical properties, especially if there is a deficiency in any of the vital chemical components.

Soil physical properties can be analysed in the field by observing a number of features describing various aspects of soil physical characteristics. Analysis of these features will give information on soil erosion and degradation and the cause of erosion (water or wind). Wind erosion is determined by assessing the levels of soil accumulation on clumps of vegetation or upslope of trees, fences or other barriers, the number of exposed roots or parent material, bare or barren plots and presence of a sandy layer on the soil surface. After determining the type of degradation taking place further assessments to quantify the levels of degradation can be made following standard procedures available in field manuals and handbooks. For further reading see Lal and Stewart 1995; Lal et.al. 1998 and Stoching and Murnaghan, 2001.

4.4.4 Water analysis

Water quantity is assessed in a number of scientific approaches that include modelling of water budgets in a catchment or basin. This usually involves measuring and monitoring changes in inflow and outflow from reservoirs to determine the amounts and times of residence of the water.

Assessment of water quantity is first done by field surveys to assess the number of water bodies in the region (rivers, lakes, reservoirs, dams, seasonal streams etc.) and further quantifying seasonal variations of water volumes.

It is not necessary to calculate the volumes of water in various water bodies in your region but it is good to obtain values of the states of some indicators of changes in volume of water. These could include water depths in lakes, reservoirs and dams and markers for river flow edges on rivers and streams. All these assessments can be done through physical observations in the field where records of the changes or deviations from the baseline data can be made.

There are cases where analysis of biological indicators can be made to show changes in water levels and shifts in shoreline over time. Many of these case assessments are qualitative and used to assess changes over a long period of time. These biological indicators are, for example, diatoms extracted from samples from lake and swamp sediment core in a chronological sequence (Ashley et al. 2004). Analysis of the composition of different taxa of diatoms will give an idea of changes in water levels. For further reading see Maitima and Olson 2001.

4.5 Methods for assessing the impacts of T&T interventions at landscape level

4.5.1 Land tenure analysis

One of the anticipated impacts of T&T interventions is on land ownership and rights of access to land. As land becomes profitable (removal of tsetse and trypanosomiasis), its value increases, attracting investors who may either buy or rent it. Changes may also occur in who works or uses the land. Young people, for example, may now find it attractive to use the land. Such changes are important to analyse in order to understand the impacts of the intervention on people and the fragmentation of land production units. These changes may have impacts on patterns of land use and may affect the type of crops produced.

Information on land tenure can be obtained by administering an appropriate questionnaire in randomly selected households in the project area. Other methods like group interviews can be used to generate qualitative information on general changes in land tenure. For further reading see Maitima and Olson 2001.

4.5.2 Cropping systems analysis

Removal of trypanosomiasis as a constraint to land use may result in numerous changes in cropping systems. People will be able to use the full potential of their land and to take advantage of the market opportunities available to them. In so doing they may change the type of crop they grow, the way they produce their crops (land management) and also change their sources of seeds as they respond to market demands. Increased profitability in livestock production will increase crop–livestock integration and most likely bring new approaches in land management. Changes in land tenure due to trypanosomiasis control might bring in immigrants who have different land management practices and crop varieties. These changes will have definite impacts on food security and socio-economics in the area.

To generate information on the types of crops planted and their relative importance each year several methods may be used. This requires information on the types of crops and the average acreage for each crop per household. Administration of appropriate questionnaires at the desired spatial scale could be a valuable way of generating the data on cropping systems.

The FITCA EMMC (The Environmental Monitoring and Management Component of the Farming in Tsetse Control Areas) project used a global positioning system (GPS) track mapping of crops on farm as a way of evaluating types of crops planted, general land cover at farm level and acreage of each cover type. This method involves GPS for tracking around all the land cover types including crop types in a sample area and generating a global information system (GIS) map for the distribution of all land cover from which you can calculate the acreage of each crop and land cover type. The FITCA project selected an area of 5 km^2 for mapping.

As an alternative to GPS track mapping, analysis of IKONOS satellite imagery was used to generate a map of land cover by different crops and vegetation to serve the same purpose as the GIS track mapping. The advantages and disadvantage of using the GPS track mapping method are shown in Table 7. For further reading see Maitima et. al. 2003 and Nagel, 1995.

4.5.3 Remote sensing

With a reduction in trypanosomiasis challenge, people will increase their livestock numbers and thus increase areas under grazing. More people are likely to settle in the disease free areas, increasing areas under settlement. Availability of more income and draft power from livestock will facilitate cultivation of more land and therefore increase land under crops. All these changes in demography and socio-economics will result in changes in land use.

To measure changes in land use we recommend the use of remote sensed data to assess both temporal and spatial changes in a given time and space respectively. Different satellite images are available and the choice of which one to analyse depends on the resolution required and the financial resources available to the project implementers. Since Land Sat images are no longer in use, SPOT 5, IKONOS and QUICK BIRD are the main options available.

Recently a number of land cover classifications covering different parts of Africa have been published. Where such classes may apply it would be good to adapt the classification by cross checking on the ground to make sure that the distinct classes are identifiable. Where such existing classifications are not applicable, a remote sensing analyst can develop one based on field surveys and interpretation of satellite images. We recommend a temporal resolution of 5-year intervals, starting with 5 years before the intervention, i.e. –5 years, current situation 0 years, 5 years and 10 years time series.

Land use is defined as the way in which people use land. Examples of classes are small-scale agriculture, grazing, wildlife reserves or industrial zones. Land cover represents the biophysical cover, e.g. savannah, broadleaf forest, tea or built up areas. In land use/cover interpretations, we use satellite imagery interpretations based on the classification system designed by the Africover project.

Assessments examine changes in land use and their impacts on land cover at different scales: at field level (e.g. transect plots and fields) and at scales determined by the resolution of aerial photographs and satellite imagery (ranging from 1:20,000 to 1:100,000), at ecosystem level, and at landscape level considering all the ecosystems that exist in a geographically defined area. The field data collected thus includes information on the class of land use and land cover in each area surveyed.

Ground measurements of the path width multiplied by the total length of the transects cleared gives the area of land cleared. It is also possible to express the areas cleared in terms of their original habitat categories like, the amount of forest cleared, bush cleared, grasslands etc. For further reading see di Gregorio, 2003; Lillesand and Kiefer, 1987; and Woodwell 1984. .

4.5.4 Map overlays

Map overlay is a technique for developing a composite impression comprising a set of maps displaying different effects of the projects or environmental characteristics and themes that describe the project area. Thematic map overlays can help identify geographic areas of particular environmental sensitivity and can visually provide clues to possible incremental and cumulative effects. The technique is valuable in mapping distributional information of migratory, vulnerable, endemic and rare species, and modelling change scenarios.

This is an easy technique to use for development of scenarios and evaluation of different interventions; it is flexible; and the models can be linked with other tools (see section on integrated impact assessment and scenario development in Chapter 7 of this volume). For further reading see Bissett, 1987.

4.5.5 Geographic information systems

GIS is a tool that is useful in mapping and conducting spatial analysis of the distribution of natural resources, farm sizes and their distribution, sampling points in the study area etc. This tool can be used before the intervention to develop baseline data and after the intervention to assess impacts. Use of GIS gives quantitative data to estimate impacts. GIS analysis describes complex spatial interactions in an explicit manner, identifying hotspots. For further reading see Gu et.al. 1999.

4.6 Assessing impacts of T&T interventions on human health

Health impact assessment (HIA) in general is commonly defined as a combination of procedures, methods and tools by which a policy, programme or a project may be judged as to its potential effects on the health of a population and the distribution of those effects within the population. Health impact assessment is a multidisciplinary process within which a range of evidence about the health effects of a proposal is considered in a structured framework. It takes into account the opinions and expectations of those who may be affected by a project. Potential health impacts of a proposal are analysed and used to influence the decision making process.

HIA can be used to evaluate the potential health effects of a project to provide recommendations, increase positive health outcomes and minimize adverse health outcomes. A major benefit of the HIA process is that it brings public health issues to the attention of persons who make decisions about areas that fall outside traditional public health arenas, such as land use or transportation.

Human health is currently treated as a complex phenomenon which cannot be limited to the absence of a disease. Both environmental and socio-economic health determinants (Box 5) are significant and require adequate protection against adverse external impacts. Most of health impacts are mediated through the biophysical component. They include health implications of exposure to environmental toxicants such as trace elements and persistent organic pollutants (POP) which have become subject to increasing concern.

Trypanosomiasis control utilizes a number of technologies with different approaches, implements used and the complexity of methods in which the control is conducted. Each of these variabilities has different implications on the health of those conducting the control as well as those living in the control area. However, T&T control is expected to improve human health in two other ways: i) removal of human trypanosomiasis reduces the risk of people contracting the disease and thus maintains a better human health status; and ii) removal of animal trypanosomiasis improves the health of livestock and with the availability of livestock products and better returns from the proceeds and sales of livestock, people are able to improve their health status by eating better and being able to afford medicine to control and treat other diseases.

Assessment of the impacts of T&T interventions on human health should therefore be robust enough to capture changes in three generalized scenarios: 1) direct impacts of the control applications to human health; 2) impacts on human health after interventions to reduce human trypanosomiasis; and 3) improvements in human health accrued from reduced risk of animal trypanosomiasis. Some of these assessments, especially the third one above, could be conducted with the assessments of socio-economic impacts of T&T interventions.

BOX 5 **Potential determinants of health considered in an HIA process**

- Biological factors—for example, age, sex and genetics
- Pre-conceptual and in pre-exposure —for example, maternal nutrition and health during pregnancy and baseline information (pre-intervention)
- Personal behaviour and lifestyle—for example, diet, alcohol, exercise and risk taking
- Psychosocial environment—for example, family structure, community networks, culture and social exclusion
- Physical environment—for example, air, water, housing, transport, noise and waste disposal
- Socio-economics—for example, employment and education
- Public services—for example, quality of and access to child care, transport, shops, education, leisure, health and social services
- Public policy—for example, economic, welfare, crime, transport and health policies

HIA builds on and brings together methods including policy appraisal, health consultation and advocacy, community development, evidence based health care and environmental impact assessment. The principles of health impact assessment are similar to those of social impact assessment and environmental impact assessment (EIA). Initially HIA was developed as a natural extension of these methods.

4.6.1 Methods of assessment

Currently there is no established analytical framework for considering health impacts. There is neither an accepted standard nor even a simple, reliable and evaluated method for carrying out HIA. Only a few assessments have been completed and these used several approaches. HIA should be thought of as a group of research activities being developed to identify health impacts of projects and policies both prospectively and retrospectively. It is a structured way of bringing together evaluation, partnership, public consultation and available evidence for more explicit decision making. The general concepts can be illustrated by looking at the guidelines in Boxes 6 And 7 below.

BOX 6 **Assessment of impacts to human health directly related to T&T control applications**

It is recommended that while conducting impact assessments of T&T interventions on human health the following steps should be taken:

Purpose

The purpose of the assessment should be to determine whether T&T control and eradication activities or the technologies used and applications made have impacts on human health. Different technologies will have different manifestations and levels of impact.

Screening process

An inter-agency, multidisciplinary steering group should be formed to determine the terms of reference and process for the assessment. Representatives from public health, the project team and the local communities should determine the scope and methods to be used. Initially a screening process is carried out on the whole area where the T&T interventions are applied to identify which component of human health would be most useful to the subject for an in-depth process. Screening uses a checklist of criteria (including the types of substances and material used to control or eradicate) to identify the components that may have the greatest impact on population health. The screening also focuses on the possible ways in which humans are exposed to the substances used, the components of the human environment that may have been exposed to the substances and the human population that may have been exposed (e.g. women, children etc.)

Semi-structured framework for assessment

The most important part of HIA is identifying and collecting evidence for health impacts that a project might create. The main determinants of health (Box 5) are combined with the core elements of T&T interventions according to the control technologies as planned in the country projects such as SAT, ground spraying and livestock insecticide treatment. This forms a semi-structured framework for assessment, used in both group brainstorming sessions and interviews with key informants, to predict potential or identify human health impacts. Informants include local community groups affected by the project, experts involved in the development and professionals involved in service delivery locally.

Identification of main health issues

The qualitative information gained from informants allows the evaluators to develop a picture of likely positive and negative health impacts to be built up, including areas of speculation and disagreement. Main issues to be identified could include exposure to chemicals, presence of dead organisms in the environment, polluted water catchments or reservoirs and chemicals in food resources in the field like vegetables. This is then combined with evidence from other sources including literature reviews, routine data sources, a community health profile and local community opinion surveys.

Prioritizing health impacts

The evidence identified above can be used to prioritize health impacts. The assessment may use a grid to subjectively estimate the measurability and certainty of impacts. The frequency, severity and probability of each impact should be determined but the information to do this is often incomplete or unavailable. However, it may be difficult to quantify with certainty what the future of many of the impacts will be, especially in the case of pre-intervention assessments. Lack of quantitative data for many impacts makes this stage the most difficult. Deciding the importance of each impact is a balance between objective evidence and subjective opinion and is obviously open to conflicts of interest arising from the different views of stakeholders.

BOX 6 **Assessment of impacts to human health directly related to T&T control applications**

Results of the process

The health impact assessment should end with a conclusion on the overall development of the project on whether it has or will have a positive effect on health, especially in the areas identified in the identification section above. Recommendations should be proposed for measures to reduce negative impacts. These recommendations should be presented to the wider project steering group and reported as acting as a catalyst to improve public health in the development. The final stage of an assessment is monitoring and evaluating the process and outcomes. It is essential to provide feedback to influence the continuing project or policy development.

BOX 7 **Assessment of impacts on human health due to reduced risks on human African trypanosomiasis (HAT)**

Purpose

The purpose of this assessment is to determine whether achievements in T&T control and eradication have impacts on human health in areas affected by HAT.

Screening process

An inter-agency, multidisciplinary steering group should be formed comprising of representatives from public health, the project team and the local communities to set up the scope of the assessments and areas for assessing the impacts. People with the highest risk of contracting sleeping sickness are women and children who are more exposed to tsetse inhabited areas during their daily activities like fetching water and firewood and looking after cattle. Though not exclusively, the screening process should therefore focus more on these groups. The criteria to be used in screening should identify the changes in human physical appearances (perhaps due to improved nutrition or improved health at community level, human activities and behaviour that people may have acquired due to the absence of the disease among their community.

Semi-structured framework for assessment

As pointed out in the previous assessment, the most important part of HIA is identifying and collecting evidence for health impacts that a project has created. The main determinants of health (Box 5) are combined with the core elements and scenarios created by removal of HAT from the community and the presence of more and healthier livestock, and healthier people. This forms a semi-structured framework for assessment, which is used in both group brainstorming sessions and interviews with key informants to predict and identify human health impacts. Informants include local community groups affected by the project, experts involved in the development and professionals involved in service delivery locally.

Identification of main health issues

The qualitative information gained from informants allows the evaluators to develop a picture of likely positive and negative health impacts to be built up, including areas of speculation and disagreement. Main issues to be identified include the determinants of health as outlined in Box 5 above. Generally changes in the number of people affected by sleeping sickness in the area, ability of people to access to areas they could not access before and the improvements in the well-being of people, especially the groups that are at the highest risk.

BOX 7 **Assessment of impacts on human health due to reduced risks on human African trypanosomiasis (HAT)**

Prioritizing health impacts

The evidence identified above can be used to prioritize health impacts. The assessment may use a grid to subjectively estimate the measurability and certainty of impacts. The frequency, severity and probability of each impact should be determined but the information to do this is often incomplete or unavailable. However, it may be difficult to quantify with certainty the future of many of the impacts, especially in the case of pre-intervention assessments. Lack of quantitative data for many impacts makes this stage the most difficult. Deciding the importance of each impact is a balance between objective evidence and subjective opinion and is obviously open to conflicts of interest arising from the different views of the stakeholders.

Results of the process

The health impact assessment should end with a conclusion on the overall development of the project on whether it has or will have a positive effect on health, especially in the areas identified in the identification section above. Recommendations should be proposed for measures to reduce negative impacts. These recommendations should be presented to the wider project steering group and reported as acting as a catalyst to improve public health in the development. The final stage of an assessment is monitoring and evaluating the process and outcomes. It is essential to provide feedback to influence the continuing project or policy development.

4.6.3 Methodological difficulties

Several issues are unresolved in the methodology of HIA. Although there is increasing agreement about the wide variety of factors that influence health (see box 5), the comparative importance of these varies across professional and public views. For assessment to be a valid tool, a shared definition of health is needed. This affects the ability to measure health impacts in various settings. Currently, models measure health impacts in different ways. All use some checklist procedure which uses the perceived determinants of health as markers for changes in health risks, e.g. using employment levels as a marker for the status of community health. The difficulty with this is that causal pathways are so complex that it is not often possible to say if an outcome will definitely be good or bad for the health of a population. Will a development such as the trypanosomiasis eradication increase local employment? And if it does will this improve health? Such health indicators can potentially measure progress towards health improvement but this is not necessarily equivalent to a measure of health impact.

One of the major criticisms of HIA is that methods used to collect and analyse evidence are not sufficiently rigorous to withstand scrutiny and challenge. The current evidence base for many health determinants is inadequate for accurately informing a process of assessment. In completed studies the principal sources of evidence have come from literature reviews and qualitative methods. A range of data sources including economic, epidemiological, quantitative and qualitative information should be routinely taken into account. However, often the most useful information is not being routinely collected. Seldom will there be the time or money available to collect primary data. Although it may be preferable for decision makers to have a quantitative measure of health impact, the limitations of qualitative estimates may have to be accepted as the best evidence available. This may limit the strength of the recommendations an assessment can make both in terms of the certainty and size of an impact.

CHAPTER 5
METHODS FOR ECONOMIC IMPACT ASSESSMENT

Traditionally, the economic impacts of T&T interventions focused on the direct and indirect costs of the disease. This section describes different methods used to assess those impacts and presents a series of tools for estimating the economic impact of T&T interventions at different levels of analysis and on the environment. These levels of analysis are:

- Herd—impacts of interventions on animal health and productivity
- Farm/household—impacts of interventions on farming/agricultural systems
- Regional/national/international—impact of interventions in other sectors of the economy and society

5.1 Methods to estimate the costs of trypanosomiasis: Direct and indirect effects of the disease

5.1.1 Longitudinal herd monitoring comparing infected and uninfected animals

This method is useful for ex post analysis of T&T interventions, when data for different years are available for the same location. The method has been used to evaluate the impact of trypanosomiasis through changes in animal productivity parameters. The animals must be frequently tested for the disease, ideally every month, and a record of their productivity parameters must be kept. The animal records are grouped into 'cases' and 'controls' according to the number of times the individuals are found to be parasitaemic and productivity parameters are compared between groups. The results of the analysis are the productivity losses because of disease, which can be monetarized using market values. This method is highly accurate, and seasonal and inter-annual variations of animal productivity are considered. However, the results might ignore considerations of what components of the losses can be realistically reduced, no references to externalities are issued and the technique might not be appropriate for herds that are highly mobile. Longitudinal monitoring is a high-cost and long-term approach since a large number of animals must be frequently tested for a number of years.

This method has been successfully used across Africa for different livestock species including cattle and small ruminants in distinct production systems. The variables to evaluate are determined by the characteristics of the production system (e.g. low-high inputs, specialized meat–milk production), and the animal tolerance of or susceptibility to disease. Most studies have focused on variables such as birth rate, birth weight, weight gain, milk offtake and mortality rate. Additional information about market prices for animals and animal by-products is required for the analysis. For further reading see Falla et. al., 1999, ITC 1997; Mahama et. al. 2005; Masiga et. al. 2002; Rowlands et. al. 1996; and Thorpe et. al. 1987.

5.1.2 Case-control site approach

This is a technique for ex post analysis of trypanosomiasis interventions and estimation of the impact of disease on animal productivity when cross-sectional data for different locations are available. The method is used to monitor the health and productivity of cattle herds kept in contiguous areas with different levels of trypanosomiasis risk during the same time period. Since the animal productivity parameters are measured for entire herds rather than for individual animals, the impact of outliers is diminished. This approach usually estimates productivity parameters of herds in an area where no intervention has been implemented (control) and compare the same parameters with those of an area where interventions are being carried out. The parameters can be collected cross-sectionally or using longitudinal monitoring. The results of the analysis are the differences in productivity between sites which are usually attributed to the effect of trypanosomiasis and monetarized using market values. However, differences in management of animal resources and environmental conditions between sites can affect the evaluation of the disease effects and should therefore include some covariates for the analysis. The results might ignore considerations of what components of the losses can be realistically reduced.

This method has been successfully used across Africa; the variables to evaluate are determined by the characteristics of the production system (e.g. low-high inputs, specialized meat–milk production) and the animal tolerance of or susceptibility to disease. Most studies have focused on variables such as birth rate, birth weight, weight gain, milk off take and mortality rate. Additional information about market prices for animals and animal by-products is required. For further reading see Feron et. al., 1987; Magona et.al., 2000; Mahama et al. 2004 Almedin and Hugh-Jones, 1995.

5.1.3 Before and after approach applied to herds or sites

This is a retrospective technique to evaluate the impact of trypanosomiasis on animal productivity. The method can be used for ex post analysis of interventions by monitoring the health and productivity of cattle herds when data for the same herd within the same location are available for two different periods usually before and after an intervention that reduces the incidence of trypanosomiasis has been implemented. The results of the analysis are the productivity losses as a consequence of disease, which can be monetarized using market values. An important advantage of this method is that environmental bias is minimised since the analysis is done at the same location. However, for cross-sectional studies some seasonal effects or inter-annual variation could affect the assessment. This approach focuses on entire herds rather than individual animals, thus reducing the effect of outliers. Nevertheless, changes in the management of animals can occur as part or after the treatment, affecting the straightforward evaluation of the disease effect. An important limitation of the method is that it only captures the value of the remaining disease not yet controlled, while missing the value of the disease that has already been successfully avoided. In addition, the results might ignore considerations of what components of the losses can be realistically reduced.

This method has been successfully used to estimate the impact of tsetse control and trypanosomiasis treatments for different animal species evaluating changes in variables such as birth rate, birth weight, weight gain, milk offtake and mortality rate. Like for the other methods used to estimate the direct impact of disease, additional information about market prices for animals and animal by-products is required. For further reading see van den Bossche et. al., 2004; Okiria et.al. Shaw, 2003; 2002 and Rowlands et al. 1999.

5.1.4 Slopes comparison

This ex post technique provides an estimate of the impact of trypanosomiasis on animal traction. The approach is useful for areas with different levels of trypanosomiasis incidence or before and after an intervention has been implemented, when data for cultivated area and oxen number are available. The cultivated area is plotted against the number of oxen owned by groups of households within and outside trypanosomiasis control areas or before and after the interventions. Comparison of the two slopes provides a measure of the relative inefficiency of oxen in the two areas that is assumed to be a consequence of disease.

This methodology usually uses data collected by rapid appraisal and community based methodologies. Data requirements are low; information on area of cultivated land and number of oxen is collected in an aggregated way rather than for individual households or animals. Thus, the method assumes that households share oxen with the neighbours and the average cultivated area is measured for the existing oxen number rather than for individual animals.

A limitation of the approach is that it is sensitive to differences in household management, which is expected after an intervention has been successful and in consequence more resources are available after the removal of the disease constraint. Thus different household management strategies can overestimate or underestimate the effects of disease on animal traction if other production factors are available. In addition, total available land and terrain characteristics could bias the results, especially in areas where land clearance and expansion of cultivation is expected after the control of trypanosomiasis. For further reading see Swallow, 2000.

5.1.5 Control expenditure

This is a technique to evaluate the impact of trypanosomiasis in the enterprise output because of changes in the variable costs of the exploitation caused by the disease.
The approach can be used for ex ante analysis of interventions when data for current expenditure in drugs are available. The method provides a broad measure of the avoided costs, the money saved by farmers if trypanosomiasis is controlled. The advantage of the method is its capacity to directly provide researchers with monetary values of the impact of disease. However, a clear cost structure is needed to understand what components of the expenditure can be realistically reduced by the interventions. In addition, although this method is appropriate to estimate the impact at farm level, when extrapolated to larger areas/scales other variables should be considered before aggregating the data, e.g. the breeds of cattle raised (e.g. trypanotolerant or susceptible), other available methods to diminish the risk (e.g. transhumance) and the capacity of farmers to pay for treatment.

This method requires that researchers collect information about the different outputs of the enterprise, the cost of trypanosomiasis treatment (curative and prophylactic) and any other variable able to influence the farmers' use of drugs. For further reading see van den Bossche et..al. 2000; Geerts and Holmes, 1998 .

5.1.6 Lost potential, revenues foregone

This tool is a conceptual framework developed to make explicit the effect of disease in the farmer's production possibilities and the changes in the production possibilities frontier because of disease interventions. It can be used to evaluate the economic consequences of production and management constraints that result from the level of infection prevalence and disease incidence in a region. The analysis quantifies the economic differences between the farmer's outputs in the current situation with disease, where low productive trypanotolerant cattle are preferred, and a new situation with lower disease risk where a different set of production factors such as cattle genotypes developed for higher productivity traits such as milk and meat will be efficient. This approach demonstrates that after disease intervention production systems change. However, the estimation of lost potential lacks accuracy. Several factors are recognized as potential sources of bias, especially since:

- The levels of adoption of new production factors are uncertain.
- The approach considers changes in the supply of the commodity assuming that prices are unchanged.

- Local environmental conditions and management practices can influence the outputs of high productive cattle breeds.
- The approach is focused on financial returns and does not consider the societal benefits of conservation of indigenous genetic resources.

To apply this approach, analysts must collect information on current practices in the region, the adoption level of new practices, the commodity offtake in both situations, market price of the commodities and the cost of the new production factors. For further reading see Hoste, 1987; Perry and Randolph, 1999.

5.2 Methods for economic impact assessment of trypanosomiasis interventions at herd level

5.2.1 Gross marginal analysis

This is a technique for evaluating the economic viability of an enterprise when quantitative enterprise data are available and the primary motivation of the farmers is to maximize profit. This tool is useful for comparing enterprises and for assessing productivity changes in enterprises at herd level because of disease interventions. The analysis is based on actual records and because fixed costs are ignored, the problem of assigning these costs to enterprise is avoided. The result from a gross marginal analysis is commonly expressed in monetary terms or as output per standard unit, to enable comparison between different alternatives.

The advantage of the method is that gross margins can be generated from on-farm records or from standard reference books. However, despite its simplicity, the gross margin analysis has limitations when applied on smallholder farming systems, since in these systems financial return is not the only criterion for enterprise selection. Gross margin analysis should only be used as a comparative tool if the analyst fully understands the farming systems for which the gross margins have been derived. In addition, the methodology gives better results when an input lasts for more than one production cycle; the cost of the input is then spread over its useful life. Another limitation is in how to take into account the fact that money used in meeting variable costs cannot be spent on something else, i.e. the opportunity cost for variable inputs. The method requires collecting information about the farm outputs produced/sold, number of animals produced and sold, market prices for the commodities, number of animals/farm outputs in stock and the estimated value per unit to calculate the gross income for the enterprise. The total variable costs of production are estimated by itemizing the different variable inputs used directly in the enterprise and for each input, recording the number of units used, the cost per unit and the variable cost for each input. The gross margin is obtained by calculating the gross income (value of production of the enterprise) and subtracting the variable costs associated with an enterprise/activity. For further reading see Norman et. al., 2002.

5.2.2 Break-even analysis

This technique relates fixed costs, variable costs and returns. The break-even analysis identifies when an investment will generate a positive return, i.e. the volume of production at a given price to cover all costs. The break-even point is the point where gains equal the losses. The advantage of the method is that it provides a relationship for costs, production volume and returns. The method can be used to evaluate the impact of trypanosomiasis interventions and tsetse control since the interventions can be able to produce changes in the fixed and variable costs of the enterprise, affecting its viability. However, there are limitations to using break-even analysis: it is best suited to examine one product at a time; it may be difficult to classify a cost as all variable or all fixed; and there might be a tendency to continue to use break-even analysis after the cost and income functions have changed. The method requires that analysts collect information about the farm outputs produced/ sold, number of animals produced and sold, market prices for the commodities, number of animals/farm outputs in stock and the estimated value per unit to calculate the gross income for the enterprise. It also requires an estimation of the fixed costs and the total variable costs of production. For further reading see Shaw, 2003.

5.2.3 Partial budget

This is a technique used for within herd analysis to establish the economic impact of the disease. The results do not show the profit or loss of the farm as a whole but the net increase or decrease in net farm income resulting from proposed changes. Partial budgets are appropriate for analysis of endemic diseases or for retrospective analysis of disease outbreaks. Partial budgets are most often used to consider the use of a new input, enterprise or method of farm management. Thus, this technique is useful to test the viability of introducing a new drug against trypanosomiasis or a new tsetse control measure.

Partial budgeting is used where costs and benefits both accrue within a single year and only the items changed by the proposed action need to be considered in the analysis. This technique is concerned with four basic elements: new costs, revenues foregone, costs saved and new revenues. These elements are combined to estimate the potential gross loss and the potential gross gain, and then estimate the potential net gain or loss by subtracting the potential gross loss from the potential gross gain. The result of a partial budget analysis is expressed as change in income. If the figure is positive, your best estimate is that there will be a gain from adopting the change. Conversely, if the figure is negative your best estimate is that there will be a loss from adopting the change.

This technique is easy to use but the results can be biased due to the technical feasibility of the proposed changes. The analysis only assesses the areas of the enterprise that are affected by the change being considered, and thus can only be used to consider changes that can be isolated from the rest of the enterprise. In addition, the budgets are based on expected values and do not incorporate risk or uncertainty. The technique compares enterprises in steady state and ignores the time taken to reach that state; the time value of money is thus assumed to be zero. For further reading see Kamau et. al., 2000 and Norman et. al., 2002.

5.2.4 Decision analysis

This is a method used to evaluate issues where the probability of particular outcomes is used to weight the economic consequences should that outcome occur. This technique is useful to evaluate the impact of control programmes for trypanosomiasis outbreaks or epidemic diseases. Decision analysis describes complex economic problems in an explicit manner, identifying the available courses of action, assessing the value and probability of possible outcomes and then making a calculation to estimate the value of each possible course of action. The method can be used on partial budget data at herd level or on cost benefit analysis at industry or national levels.

The advantage of the methodology is that expected results do not have to be expressed in monetary units; this can be important when studying smallholder farming systems. Decision analysis combined with investment appraisal is useful where the frequencies of disease outbreak are unknown. Outputs from the investment appraisal can be used as the outcome values. However, an important limitation of the method is that it ignores the time value of the money. The method requires information about the events over which the decision maker has control (alternatives), the probability of occurrence of chance events and the value of various outcomes (normally expressed in monetary terms). Multiplying the probability of occurrence of an event (such as the death of an animal) by its value yields the expected value of the outcome. Decision analysis involves the construction of pay-off tables or decision trees, where the net benefit of each path through the tree is identified at the terminal branch. Sensitivity and threshold analyses are later performed to establish the point beyond which the original decision would not be reversed. For further reading see Clemen, 1991 and GU et. al., 1999.

5.2.5 Investment appraisal

This is a technique to examine the impact of a change in disease over a number of years with a flow of cost and benefits at the herd level. The investment appraisal is used to examine how proposed changes in health management and treatment will affect the output of the livestock system under study. The method uses three decision making criteria: net present value, internal rate of return and the benefit–cost ratio, to compare the present values of benefits and costs of the proposal. Each of these criteria has strengths and weakness, so the results of the analysis are commonly presented with the three measures of project worth. Thus, if net present value is negative, then investment is not worthwhile, while if the internal rate of return exceeds the opportunity cost of the money the project is worth further consideration and if the benefit–cost ratio is greater than 1 the investment is worthwhile.

The technique takes account of the time involved for a system to reach a steady state and of the time value of the money. However, it is a deterministic approach and the method lacks a component to consider the probability of occurrence of a disease outbreak or the success of a treatment or control strategy. The method requires the analyst to identify all benefits and the time the benefits occur and identify all costs and the time the costs occur. Investment appraisal provides the basis for much economic impact assessment of livestock disease and control. However, it is difficult to assess the costs and benefits from livestock systems, so generally the costs associated to disease are broadly calculated through mortality and morbidity losses and the costs of control and eradication of the disease, while the benefits are estimated considering animal offtake and market prices. For further reading see Savvides, 1994.

5.2.6 Dynamic herd models

This is a technique to evaluate the impact of trypanosomiasis on herd productivity (see also Box 8). The tools can be used for ex ante analysis of disease interventions focused on changes in animal productivity over time. These tools allow aggregation of herd parameters into measures of livestock capital and overall offtake of live animals and milk. The common outputs of a herd simulation model are the changes in herd size and structure and herd productivity along a defined period. Most of the herd simulation models are linked with some sub-models to calculate productivity efficiency or economic returns and the subsequent simulation results could be expressed as output/input, e.g. animals/hectare or monetary values.

This technique therefore has been used as a complement to GIS tools and economic surplus models. The main advantage of a herd model is its flexibility to develop scenarios and evaluate benefits and costs of different interventions. However, the outputs of the herd model are dependent on the model assumptions and complex models require a larger amount of data for calibration. Specific data requirements are dependent on the model, although most of them include variables such as initial herd size, birth rate, mortality rate and net offtake. More complex models could require data for the herd structure in terms of age and sex and age specific mortalities and offtakes. For further reading see Shaw et al. 2006.

BOX 8 **Demographic data for impact assessment:**

Basic and crucial parameters for quantifying the dynamics and the productivity (in numbers of animal produced per year) of livestock populations are annual demographic rates, e.g.:

- parturition rate
- prolificacy rate (number of offspring per parturition)
- natural death rate
- offtake rate (slaughtering and sales etc.)
- intake rate (purchases and loans etc.).

Demographic rates represent biological and herd management traits (Landais and Sissokho 1986; Wilson 1986). They can be used as input data for mathematical models to predict a population's dynamics in different contexts (Tacher 1975a; Tacher 1975b; Itty 1995; Lesnoff 1999; Lesnoff 2000; Texeira and Paruelo 2005) and the impact of interventions on the global productivity of the populations (Upton 1989; Baptist 1992; Lesnoff et al. 2000; Hary 2004).

Herd monitoring models are the gold standard within the on-farm survey methods. The method involves following a sample of herds in which animals are identified individually, e.g. with ear tags. Well-trained enumerators visit the herds every two weeks or every month and record all the demographic events occurring between successive visits (births, deaths, slaughter, exits and entries of animals in the herd). Herd monitoring models provide complex data since observations are longitudinal and individual-based. The method is widely used and specific management systems are available to store, manage and analyse these data. For example, CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement), France, developed the free software Laser (http://laser.cirad.fr/) resulting from more than 20 years of experience of herd monitoring in tropical systems (Faugère and Faugère 1986; Lancelot et al. 1998). Another example is the commercial software Interherd developed by InterAGRI (http://www.interagri.org) in Reading, UK, and used by ILRI in different dairy projects. Herd monitoring models are well-adapted (and should be recommended) for precise investigations of scientific questions. They provide reliable data on demographic rates. Nevertheless, their implementation can be relatively time-consuming and they are difficult to reproduce on a large scale (like national levels).

Alternative methods are the retrospective surveys based on cross-sectional interviews of the farmers and on their mental records of the livestock demography. Two principal methods have been used in the past (SEDES 1975; CIRAD-IEMVT 1989; ILCA 1990):

- In the first method, the task for the interviewer is to get the number of the demographic events (per type of event) that occurred in the herd during the 12 months before the survey.
- In the second method, sometimes called the 'progeny history' approach, the task for the interviewer is to reconstruct the complete reproductive history (approximate dates or ages of parturitions and number of offspring per parturition) of a sub-sample of females well-known by the farmers and present in the herd at the time of the survey. The interviewer also collects the history of their progeny (here the task is to identify if a given offspring is still living in the herd at the time of the survey and, if not, the cause of the exit: death, sale etc.).

Both methods assume that the retrospective information is a reliable approximation of the real events. These methods are much simpler to implement in the field than herd monitoring, but the data they provide are less precise and reliable.

5.3 Methods for economic impact assessment of trypanosomiasis interventions at the farm/ household levels

5.3.1 Optimization approaches

This is a set of mathematical techniques that provides the solution to a problem within a farming system, which is optimal with respect to a set of objective and constraints functions. Optimization models are of interest to researchers carrying out impact assessment of disease and disease control at household, sector and national levels. These techniques can be used to assess how a general decision maker will react to a change in the prevalence or incidence of a disease related variable. The result of the optimization provides information on the optimal allocation of finite resources to obtain the highest output for the objective function which represents the priorities of the manager of the farming system. The approach can be expanded for multiple objectives or multiple criteria decision analysis. However, the effectiveness of the approach depends on the appropriate specification of the objectives of various stakeholders. In addition, the use of the optimization model as a predictive tool requires the assumption that the objective function will remain unchanged over time. The structure of an optimization model does not allow easy adaptation to different farming systems and the variables required for the analysis are dependent on the specified objective and constraint functions of the problem. For further reading see Habtermariam et. al., 1984; Kobayashi et. al. 2005; and Scott et. al., 2003.

5.3.2 Simulation techniques

Simulation models are abstract representations of particular facets of reality built for specific purposes, e.g. to evaluate the impact of trypanosomiasis on human welfare.

They are a method used where the issue is complex and the economic implications of an erroneous decision are substantial. The development and use of epidemiological economic models considers more closely the nature of the problem and interactions among various effects. The simulation models operate upon input data to produce output data which can be used for predictive purposes, especially in:

- systems that cannot be solved or investigated using optimization methods
- systems which contain many sub-systems that cannot easily be controlled and studied simultaneously
- systems which cannot be subject of experimentation or that involve highly dynamic relationships over many time periods (Rushton et al., 1999).

Simulation models are very flexible but developing and calibrating them is expensive and time consuming. Similar to the optimization models, the variables required for the analysis are dependent on the problem. Data shortages and model assumptions can have serious consequences on model outputs. For further reading see Habtemariam et. al. , 1982; Jusot et. al., 1995; Muller, et al. 2004.

5.4 Methods for economic impact assessment of trypanosomiasis interventions at the sector, national and international levels

5.4.1 Cost–benefit analysis

This is a method that compares the costs and benefits that arise from programmes and interventions in animal health, in terms of their financial or societal welfare effects in more than one time period. The method is used to compare and contrast different strategies for disease control, especially for long-term programmes at a national or regional level. It is particularly useful for analysis of interventions where the actions of one livestock owner affect the welfare of other livestock owners, or external costs are imposed on producers. The outputs of the cost–benefit analysis include a set of investment criteria, such as net present value, internal rate of return and cost–benefit ratio, which provide guidance regarding project feasibility. The advantage of the methodology is its comprehensiveness; the approach is easy to understand and intuitive. The cost–benefit analysis includes economic, environmental, biological and medical effects and incorporates the time value of money. The data requirements are high and include information about productivity impacts, costs and prices, elasticities, adoption rates, discount rates and environmental valuation of impacts. For further reading see Kamuanga, 2003, Politi et al., 1995.

5.4.2 Economic surplus

This is a technique to assess the economic impacts of changes in the supply and demand of a commodity. These changes can be a consequence of the use of an animal disease control method or animal management in a specific geographic area. The economic surplus method has application to assess economic impacts of animal disease control technologies at regional, national and international levels. The method quantifies the impact that changes in animal health have for both the producers and consumers of the commodity. The analysis is based on the premise that changes in animal health have an effect on the supply of the commodity or commodities being produced. Analysis takes place to estimate the shift in the supply and the changes in the price paid for the commodity by consumers in society.

The analysis can be made ex post by collecting appropriate data or ex ante using expert opinion. Economic surplus provides a flexible framework that can be extended to national and international levels, and can be used in combination with other tools such as GIS and herd simulation models. However, economic surplus analysis requires a large amount of economic and technical data that takes much effort to collect, process and analyse. The information needed to perform the analysis includes: productivity impacts, costs and prices, elasticities, adoption data and discount rate. This method has been successfully used to estimate the impact of the development of a trypanosomiasis vaccine in Africa. This included biophysical, economic and spatial aspects of the disease that provided information about the potential effects of the vaccine on the reduction of production costs of milk and meat, the increase in the supply of these products and the reduction of prices to consumers. For further reading see Kristjanson et. al., 1999.

5.4.3 Input-output and social accounting models:

Input-output (I-O) and social accounting models (SAMs) are multi-sector models that summarize the economic transactions in an economy. These approaches can be used to compute the impacts of various types of exogenous shocks such as disease outbreaks on the performance of diverse sectors in the economy. The I-O models follow the flow of inputs into the livestock sector from every other sector in the economy (e.g. services, agriculture and manufacturing) and the flow of outputs from the livestock sector to each of these other sectors. The SAMs also include the distribution of factors of production (land, labour and capital) to households and other institutions in addition to the productive sectors found in the I-O. To apply these methods, an input-output table is constructed by aggregating different sectors in the economy into broad groups. Sales made from a given sector to each of the other sectors in the economy should be recorded. Information about consumption, investment and net exports is also required.

For these methods, the changes in outputs are calculated through simulations that alter the level of final demand. Different disease effects could be simulated by adjusting final demand in the livestock sector as suggested by an epidemiological model or an assumed exogenous shock. The advantage of this methodology is its ability to capture links between economic sectors. The approach can therefore show, for example, how a one unit change in demand for meat exports would be transmitted throughout the economy in terms of changes in the production in each sector.

The limitation of the model is that the changes in the economy are only due to shifts in the demand curve rather than from supply constraints. In addition, I-O models do not allow for changes in prices and are unable to consider dynamic changes in sector over time. For further reading see Caske et. al., 1999; Garner and Lack, 1995; Mahul and Durand, 2000.

5.4.4 Partial equilibrium models (single sector and multi-market models)

Partial equilibrium models define functional relationships for supply and demand for a specific commodity at a specific time and place. Supply and demand are represented as mathematical functions that constitute constraints in an optimization framework. These models can be used to estimate national or aggregate impacts of disease and to analyse agricultural policies, international trade and environmental issues. Partial equilibrium approaches are especially useful when measuring changes in prices, links across markets or changes in welfare. The method requires a basic understanding of the development and meaning of supply and demand functions within the context of a given system. The partial equilibrium analysis can be conducted with respect to one sector (single sector models) or multiple sectors (multi-market models). The changes in the equilibrium prices and quantities are used to derive changes in producer and consumer surpluses. The information needed to perform the analysis includes productivity impacts, costs and prices, elasticities, adoption data and discount rate. For further information see Mangen and Burrell, 2003; Paarlberg et. al., 2002 Rich, 2004 and Schoenbaum and Disney 2003.

5.4.5 Computable general equilibrium models

This approach combines the input-output and multi-market partial equilibrium models to represent the effects of disease on the entire economy. The computable and general equilibrium models (CGE) can address questions concerning impacts across sectors, categories of households and employment groups. In addition, the models can address changes in prices, the reallocation of labour and capital markets and longer-run impacts.

The model provides information about how a shock in the economy, such as an animal disease outbreak, would transmit throughout all sectors of the economy and the potential reverberations on national income trade and employment. CGE potentially gives a larger amount of information than other models but is expensive and the interpretation of results can be problematic depending on the level of aggregation of the data. For further reading see Blake et. al., 2002 and Perry et. al., 2003

5.5 Methods for the economic valuation of the environmental impacts of trypanosomiasis interventions

5.5.1 Market price method

The market price method is a tool for assessing the impact of disease interventions on the society, valuing the changes in quantity or quality of several ecosystem goods or services bought and sold in commercial markets (e.g. fish, timber and fuel wood) based on the quantity people purchase at different prices, and the quantity supplied at different prices. The method can be used to quantify in monetary terms some of the direct or indirect impacts of animal health interventions on natural systems, based on the direct use value of several goods and services whose quantity or quality has been altered with the intervention.

The standard method for measuring the use value of resources traded in the market place is the estimation of consumer surplus and producer surplus using market price and quantity data. The method provides the value of the economic losses due to the intervention as the sum of lost consumer surplus and lost producer surplus.

The method uses observed data of actual consumer preferences and standards, accepted economic techniques. People's values are likely to be well defined since the method captures the individual's willingness to pay for costs and benefits of goods that are bought and sold in markets. Price, quantity and cost data are relatively easy to obtain for established markets. The main limitation of the approach is that markets are available for only a limited number of goods and services and may not reflect the value of all productive uses of a resource. In addition, the method has limitations assessing changes that affect the supply of or demand for a good or a service. The true economic value of goods or services may not be fully reflected in market transactions because of market imperfections and/or policy failures. The method may overstate benefits since the market value of other resources used to bring ecosystem products to markets are not deducted. Seasonal variations and other effects on price must be considered.

To apply this methodology the analyst requires data to estimate consumer surplus and producer surplus. To estimate consumer surplus, the demand function must be estimated. This requires data on the quantity demanded at different prices, plus data on other factors that might affect demand, such as income or other demographic data. To estimate producer surplus, data on variable costs of production and revenues received from the good are required. For further reading see Ko et. al. 2004.

5.5.2 Productivity method

The productivity method is a tool to estimate the direct or indirect impact on society of disease interventions that generate changes in the quantity or quality of ecosystem goods and services that are factors of production for commercially marketed goods. The method is convenient where the ecosystem goods and services are used, along with other inputs, to produce a marketed good. Changes in the quantity or quality of these goods and services (e.g. changes in water quality and soil quality) may generate changes in production costs and/or productivity of other inputs. This in turn affects the price and/or quantity supplied of the final good and may also affect the economic returns to other inputs. Considering that changes in quality or prices of the final good will affect consumer surplus and changes in productivity or production cost will affect producer surplus, then changes in the economic surplus will provide an estimate of the economic value of environmental impacts. The advantage of the approach is that it is easy to understand and is intuitive. Data requirements are limited and the relevant data may be readily available or obtained from simulation models; this makes the method relatively inexpensive to apply. However, the method does not measure the value of non-marketed environmental goods and services; hence, the inferred value may understate the true impact value to society. Some lags in temporal and spatial effects can occur since changes in productivity associated with the environmental effects may take a long time to become evident to farmers, thus scientific understanding of the relationships between the changes and productive outcomes are needed.

The method requires data regarding how changes in the quantity or quality of ecosystem goods or services generate changes in consumer surplus and/or producer surplus. Therefore data for costs of production of the final good, supply and demand for the final good and supply and demand for other factors of production are needed to estimate the economic value of environmental impact. For further reading see Barbier, 2000; Kumar and Rao, 2001.

5.5.3 Hedonic pricing

The hedonic pricing method is a tool to estimate the direct or indirect impacts on society of disease interventions that generate changes in the quantity or quality of an ecosystem good or service. The premise is that market prices reflect environmental and non-environmental attributes and that surrogate markets will reveal consumer behaviour. The method is useful to estimate in monetary terms the economic impact of programmes or projects that generate changes in environmental quality such as air, water and noise pollution or changes in environmental amenities, such as aesthetic views, through the differences in market prices of real estate in areas with different environmental impacts, after controlling for other attributes.

Since the hedonic pricing method is designed to control non-environmental attributes, then the remaining value differentials of the real estate can be surrogated values of the non-priced environmental goods and services. Hedonic functions for the price of real estate considering a vector of environmental and non-environmental characteristics are estimated, and the coefficients of the model can be used to determine the implicit price associated with some environmental characteristics, holding all other factors constant.

The method has the advantage of being based on current choices and it is flexible enough to be adapted to many different situations. In addition, the information on real estate prices is commonly reliable, available from many sources and property markets are relatively efficient and competitive. However, the surrogate markets capture only the direct consequences of changes in environmental quality that affect the price of real estate properties under the assumption that users can perceive the differences in environmental quality and, given their income, they can select the combination of features they prefer. Nevertheless, there are many sources of market distortions and the results are influenced by model specification. The complexity of the analysis and the time and expense to carry out an application depend on the availability and accessibility of data.

The specific variables to measure are dependent on the question to be addressed in the study and environmental impact to assess. Generally, one needs cross-section and/or time-series data on real estate property values and property and household characteristics for a defined market area that includes different levels of environmental quality. In competitive markets, prices for real estate can be used to value changes in quality or quantity of environmental goods or services. Then it is possible to estimate econometrically a hedonic function for the price of a given real estate property, considering a vector of diverse environmental characteristics such as soil depth, scenic view, air quality or water availability and a vector of socio-economic characteristics such as buyer attributes, population density, distance to market and urban areas. The coefficients of the estimated function represent the implicit price associated with the environmental characteristics, keeping all other factors constant. For further reading see le Goffe, 2000 and Latouche et. al., 1998.

5.5.4 Travel cost

The travel cost method is a surrogate market tool to estimate the direct or indirect impact on society of disease interventions that generate changes in the quantity or quality of ecosystems or sites used for recreation. The method estimates the economic benefits or costs resulting from animal disease interventions that generate environmental impacts such as changes in environmental quality or costs of access to a recreational site, or elimination or creation of a recreational site. It is a useful tool to evaluate the effect of animal disease intervention on tourism activities.

The basis of the method is to derive a demand curve from data on actual travel costs, under the premise that the time and travel cost expenses that people incur to visit a site represent the ‘price’ of access to the site. Analogous to estimate people’s willingness to pay for a marketed good based on the quantity demanded at different prices, the travel cost method estimates people's willingness to pay to visit the site based on the number of trips that they make at different travel costs. Using survey data, the demand curve for the average visitor, i.e. the relationship between number of visits and travel costs and other relevant variables can be specified. The area below this demand curve gives the average consumer surplus, which is multiplied by the total relevant population to estimate the total consumer surplus for the site.

The method is relatively inexpensive to apply. The methodology is based on the current decisions of users rather than stated preferences and the results are relatively easy to interpret and explain because the method uses common techniques to estimate economic values based on market prices. However, the method cannot be used to measure non-use values or off-site values provided by the natural system. The approach is only suitable for goods and services recognized by the users, because the methodology considers that the behaviour of people to changes in travel costs is similar to their response to price changes in other markets.

The method is not useful to estimate ex ante effects of interventions that potentially change environmental conditions. To use the method, a high level of collaboration with users is needed. Several problems occur when defining and measuring the opportunity cost of the time while travelling. The effect of substitute destinations and multi-purpose trips can generate results that will be biased or overestimated. In addition, the method is sensible to the approach and functional form used to estimate the demand curve and the choice of variables included in the model. The data requirements depend on the approach: a simple zonal travel cost will need mostly secondary data complemented with some simple data collected from visitors. An individual travel cost approach requires a more detailed survey of visitors, while more complicated statistical techniques (such as travel cost using random utility approaches) need surveys that are more extensive and complementary data. Generally, data regarding the origin of the visitors to estimate the distance travelled, the number of visits in a defined period, the number of days involved in the trip, the reasons for the travel, and the time spent at the site and other destinations is collected. In addition, travel expenses, income and some socio-economic characteristics of the visitor are also collected, as are data regarding potential substitute destinations and perceptions of environmental quality at the selected site. For further reading see Font 2000; Turpie and Joubert, 2001.

5.5.5 Damage cost, avoided cost, replacement cost and substitute cost methods

This set of methods provides estimates of the economic impact of animal disease interventions on the environment by quantifying the value of ecosystem goods or services based on the costs of avoiding damages, purchasing substitutes or replacing the altered functions provided by natural systems. The methods are developed under the common assumption that since people incur costs to avoid damage, to replace or to provide substitutes for ecosystem goods or services then those services must be worth at least what people paid to replace them, avoid the damage or acquire the substitute. However, these estimates do not represent the people's willingness to pay for the products or service, and the method does not provide strict measures of economic values. These methods can be used to assess the economic impact of animal disease interventions that directly or indirectly affect the capacity of natural systems to provide goods or services for local communities. Due to their limitations, these methodologies are only suitable after the society has indicated that the value of the goods and services provided by the environment to the affected people is greater than the estimated costs of the project (e.g. approved spending for the project). The monetary value of the costs incurred by people to avoid damage, replace or provide substitutes for ecosystem goods or services should represent a rough estimate of the value of those services.

The advantage of these methods is that they can provide at least a rough measure of the value of ecosystem goods or services which may be difficult to value by other means when data or resource limitations make it impossible to estimate people's willingness to pay for them. These methodologies have many limitations and assumptions. The most important limitation is that they do not consider social preferences for ecosystem services or individual behaviour in the absence of those services. Without evidence that the public will demand an action to the change in the quality or quantity of an ecosystem good or services, these methods are not useful to provide an economically appropriate estimator of the value of these ecosystem services, since there is no certainty that the affected people would be willing to pay for the identified least cost alternative merely because it would supply the same benefit level as the original service. Furthermore, despite the knowledge that costs are usually not an accurate measure of benefits, these methods share the assumption that the expenditures to maintain or replace the ecosystem services are valid measures of the benefits provided. These methods can underestimate or overestimate the benefits, since simplistic applications do not consider the degrees of substitution between the alternative and the natural good or service, nor their non-use values. The incurred costs may also serve other purposes and these external benefits are usually not considered in the analysis. The values of the alternatives to mitigate damage or avoid costs tend to be arbitrary and limited by the income, commonly not representing the social scarcity value of the resources.

Initially information regarding the ecosystem service in terms of how it is provided, who the users are and how its level of provision was affected, is collected in the field and complemented with secondary sources. Later for the damage cost method, an estimation of the potential damages in the property for a defined period is developed and used to calculate in monetary terms the value of the potential damage or the amount that users will spend to avoid that damage. For the replacement or substitute cost method, after collecting the initial information on how the level of provision was affected, the next step is to identify the least costly alternative means of providing the service and then calculate the cost of the substitute or replacement service. For further reading see Holl and Howarth, 2000.

5.5.6 Contingent valuation

The contingent valuation (CV) method is a tool used to estimate economic values of all kinds of animal health interventions and their impact on the environment. It can be used to estimate both use and non-use values and it is the most widely used method for estimating non-use values. It is also the most controversial of the non-market valuation methods.

The contingent valuation method involves directly asking people in a survey how much they would be willing to pay for a specific intervention. In some cases, people are asked to indicate the amount of compensation they would be willing to accept to give up a specific intervention or service. In economic terms, the contingent valuation method estimates the Hickisian consumer surplus—either the compensating variation or the equivalent variation—due to changes in the provision of public goods. This is a flexible tool that can be used for ex ante and ex post assessments. CV is the most widely accepted method for estimating total economic value, including all types of non-use, or 'passive use', values. CV can estimate use values and existence values, option values and bequest values.

The major criticism of the results of CV is a series of biases. These biases focus on two different aspects: validity (accuracy) and reliability (reproducibility). The validity refers to the capacity of CV to measure the true economic values and includes content, criterion and construct validity. Reliability requires that in repeated measurements, the true value of the phenomenon does not change or if it does, the measure with a reliable method will change accordingly. Several other sources of error are consequences of embedding, sequencing, information and elicitation effects, and hypothetical and strategic bias. The method has some reliability problems which are assessed testing for convergent validity or testing-retesting methods.

The specific variables to measure and include in the questionnaire will necessarily be case dependent. However, some guidelines described as reference operating conditions are available. These recommendations suggest that:

- the respondents should be familiar with the goods or services to be evaluated
- the scenarios should be presented without uncertainty
- the interviewer should avoid asking for the willingness to accept
- the payment vehicle should be realistic
- the interviewer should use dichotomous choice formats that include specific questions to minimize part-whole problems and include theoretical validation testing.

For Further reading see Bayoumi, 2004; Scarpa et. al., 2003.

5.5.7 Contingent choice

The contingent choice method, like contingent valuation, is a tool used to estimate both use and non-use values. However, contingent choice does not directly ask people to state their values in monetary terms. Instead, values are inferred from the hypothetical choices or tradeoffs that people make. Contingent choice, also called conjoint analysis, is useful to measure preferences for different characteristics or attributes of a multi-attribute choice. This method is especially suited to policy decisions where a set of possible actions might result in different impacts on the well-being of people because it focuses on tradeoffs among scenarios with different characteristics. The contingent choice method asks the respondent to state a preference between one group of services or characteristics, at a given price or cost to the individual, and another group of characteristics at a different price or cost. In addition, while contingent choice can be used to estimate monetary values, the results may also be used to rank options, without focusing on money values.

The method can be used to value the outcomes of an action as a whole, and the various attributes or effects of the action. The method allows respondents to think in terms of tradeoffs between alternatives, which may be easier than directly expressing monetary values thus increasing consistency of responses because they do not present choices between environmental quality and money like the contingent valuation method. This methodology estimates the relative values or priorities of users, providing valid information for policy decisions.

Lack of familiarity of respondents with some tradeoffs hinders the evaluation. Some biases can appear as a consequence of the complexity of choices or their high number. A limited number of choices can also represent a source of error because it may force respondents to make choices that they would not voluntarily make. Translating the choices to monetary values is not a simple process and the validity and reliability of the method for valuing non-market commodities is largely untested. For further reading see Gyrd-Hansen, 2004, Hall et. al. 2004; Rolfe et. al., 2000.

CHAPTER 6
METHODS FOR SOCIAL IMPACT ASSESSMENT OF TRYPANOSOMIASIS INTERVENTIONS

This section describes different tools to assess the social impacts of T&T interventions at different levels. These levels are:

- Beneficiary level: impacts of interventions on the target human groups
- Stakeholder level: impacts of interventions on the different beneficiary and non-beneficiary groups and organizations involved or affected by the intervention
- Society level: impact of interventions on the society

6.1 Methods for social impact assessment at the beneficiary level

6.1.1 Beneficiary assessment

This is a qualitative research tool used to evaluate and monitor human and animal health projects based on participatory assessment and direct consultation with those affected by and influencing the interventions.

The method can be used to develop ex post analysis of reforms and monitor the impact of human and animal health interventions when transmission channels and affected groups are clearly defined. It can be used as an ex ante tool to evaluate proposed reforms, identify constraints and receive feedback from beneficiary stakeholders. The results of the assessment provide information on the perception of the problem by the beneficiaries, their reception to the project and the positive and negative effects of the implementation of trypanosomiasis interventions. This method is a complement to other social impact approaches such as stakeholder analysis and institutional analysis. Beneficiary assessment is less resource intensive than other tools and some quantitative analysis could be developed with the beneficiary feedback. The method requires collecting background information on stakeholders, on cultural, ethnic or socio-economic variations, and on the variables determining whether specific groups would be affected (such as type of access). The data collection techniques include conversational interviews, focus group discussions and direct and participant observation. For further reading see Salmen, 1989, 2002.

6.1.2 Poverty diagnostics and dynamics assessment

Stages of Progress analysis

The Stages of Progress is a participatory and community-based methodology for studying poverty dynamics and identifying the associated reasons. It was developed by professor Anirudh Krishna of Duke University, and it has been utilized effectively in investigations carried out in different parts of India, Kenya, Uganda, Peru, and North Carolina, USA.

The Stages of Progress methodology provides a relatively rapid, cost-effective, accurate and participatory way to learn about poverty processes at both the community and the household levels. The methodology generates very useful results in terms of identifying the poor, understanding the factors that push people into poverty and pull people out of poverty, the livelihood options associated with different levels of assets and poverty, and the asset constraints to the adoption of attractive livelihood options.

The method involves first characterizing your study area into livelihood patterns based on means of production, peoples' values, attitudes and aspirations. This is done through group interviews with communities and or application of other PRA techniques. Through participatory rural appraisal it is possible to develop a list of progressive stages of wealth (indicators) based on commonly accepted or valued belongings or possessions one would have if and when money is available based on observations or needs assessment by the community.

An assessment therefore on the number of households moving up or down the sequence of stages during a given time period will give a good indicator of how one is doing on poverty.

The example 1 below represents a typical sequence of these Stages of Progress for rural areas (as recorded in three villages in Nyeri District of Kenya) and example 2 represents the sequence reported in four communities studied within Nairobi city.

Example 1. Stages of Progress as described by the villagers in a rural farming community in Kenya.

1. Purchase Food
2. Purchase clothing
3. Repairs to house
4. Primary education for children
5. Purchase a small water tank
6. Purchase small livestock

Poverty cut off line: Below this line, households are considered no longer poor

7. Purchase a calf
8. Rent a shamba for farming
9. Secondary education for children
10. Investing in small business
11. Construct/Purchase a bigger water tank
12. Construct a semi permanent house
13. Purchase a piece of land
14. Expand business

Prosperity cut off line: Below this line, households are considered relatively well off

15. Purchase more land
16. Purchase a vehicle

Example 2. Stages of Progress reported urban communities

1. Purchase Food
2. Purchase clothing
3. Rent a small house
4. Primary education for children
5. Invest in small business

Poverty cut off line: Below this line, households are considered no longer poor

6. Rent a bigger house
7. Secondary/college education for children
8. Expand business (kiosk/retail shops)
9. Purchase a plot in an estate

Prosperity cut off line: Below this line, households are considered relatively well off

10. Expand business (wholesale shops)
11. Develop plot (build rental houses)
12. Purchase a vehicle

These stages may vary with communities and it is therefore necessary to develop the list that is relevant for the communities we assess. For further reading see: Krishna A., et. al. 2004 and Kristjanson P., et. al. 2006

6.2 Methods for social impact assessment of T&T interventions at stakeholder level

6.2.1 Participatory appraisal

This is a set of techniques that provides a quick, systematic and cost-effective picture of livestock conditions and veterinary problems, especially in agropastoral communities. The techniques can be used for needs assessment and feasibility studies and to identify priorities and implement and monitor interventions. Their main value lies in their ability to investigate, analyse and evaluate constraints and opportunities and make informed and timely decisions, in addition to finding practical solutions to animal health problems involving the community and including the views of farmers.

The method uses several types of diagrams to summarize and present the information collected in the field. Besides histograms, bar charts, pie charts and maps the most commonly used techniques are:

- Transects: these summarize the most important features of the different areas and ecozones and are useful in showing spatial differences and trends.
- Seasonal calendars: these highlight the temporal patterns of human activities, production and biological events (including diseases). These factors can also be plotted against climatic data.
- Flow diagrams and decision trees: these clearly present the key factors that may influence decision making and the consequences derived from such decisions or other changes.

Rapid assessment methods provide complementary qualitative information for other methods such as optimization approaches. These methodologies are uncomplicated, reliable and cost-effective for collecting information on which to base tsetse intervention decisions. However, the presence of outsiders can influence people's behaviour and responses may be altered to please, confuse or deceive the researchers. In addition, during group discussions and meetings, the literate and members of the elite may receive more attention than others and people may avoid openly expressing their opinions in public.

The method requires collecting:

- background information including demographic data on people and animals and the role of livestock in the livelihoods of farmers
- disease related information and other factors affecting the welfare of people
- production information: species and breeds of livestock kept, husbandry practices, sources of feed, gender division of labour, average production figures and their seasonal

patterns, foods of animal origin most commonly produced, consumed or sold and main markets for livestock products

- seasonal information: local cropping calendars, seasonal variations in labour demand, important festivals and seasonality of supply, demand and prices for livestock and wildlife products.

6.2.2 Stakeholder analysis

This is a qualitative methodology used to determine the interests and influence of the different groups involved in a project. The method can be used for ex ante and ex post analysis of structural and sectoral reforms in trypanosomiasis interventions and animal health projects.

The stakeholder analysis might provide information of the potential social and political effects of the trypanosomiasis interventions and the perceptions and roles of different ethnic, religious or linguistic groups. The method can be used to define categories for analysis and to identify affected groups, their conflicts and influences in order to develop strategies for overcoming negative distributive effects. This method has the advantage of simplicity and low cost, complementing other approaches such as social impact analysis. However, the absence of statistical sampling procedures obligates a careful selection of respondents and interpretation of data.

Stakeholder analysis is iterative and the variables to consider are case dependent. Initially, the analyst needs to collect background information on constraints to effective project implementation. Later, specific stakeholders from diverse groups of interests will be identified through interviews with key informants. Finally, a survey focused on community and animal health issues complemented with quantitative secondary data will be used to determine the influences and interests of stakeholders. For further reading see Collins et. al., 2002; Bianchi, R and Kossoudji, 2001 .

6.3 Methods for social impact assessment at society level

6.3.1 Social capital assessment

This is a set of integrated quantitative and qualitative methods used to evaluate the role of institutions, networks and norms in the promotion of collective action. These tools can be used to evaluate the importance of some proxies for social capital in collective actions related to trypanosomiasis and tsetse control.

The analysis provides information about the effect of the disease in the community, the institutions and organizations that are more affected, and the interest of different social groups in participating in T&T interventions. In addition, the method is able to indicate the importance of norms, values and group characteristics in developing their own initiatives or supporting or resisting externally promoted interventions.

This approach is a complement to other social impact assessment techniques such as stakeholder analysis, institutional analysis, social impact analysis and beneficiary assessments. Social capital is a multidimensional concept and the assessment tools must be able to capture their bonding, bridging, structural and cognitive aspects. To be operative, some proxies for social capital relevant to the study should be defined. However, if some indexes are defined, the subjectivity in the weight of the involved variables could be a problem. Different techniques such as surveys, key informant interviews and focus groups are used to obtain quantitative and qualitative information at the household, community and institutional levels regarding the role of organizations and their membership in aspects such as solidarity, trust, cooperation and conflict resolution in the context of the disease interventions. For further reading see Lomas, 1998; Stephens et. al., 2004.

6.3.2 Social impact analysis

The social impact analysis is an iterative framework based on detailed social information to identify and analyse the impacts and responses of animal health intervention on people and institutions. The framework is useful for investigating the impacts of trypanosomiasis interventions and animal health projects on the society, especially involving the effects on vulnerable groups and the poor.

A social impact analysis provides contextual information of the social and political systems in the area of the project. The analysis identifies the different affected groups along the development of the project and their preferences, priorities and capabilities to develop coping mechanisms to mitigate negative impacts.

This method is a complement to other social impact approaches such as stakeholder analysis and institutional analysis. Different techniques are used to obtain both quantitative and qualitative data from a representative sample of a particular region or population group relevant to a particular project. The method can be used even when national household data do not exist or do not contain the specific information needed to assess reform impacts. However, the method has limitations when the transmission channels and groups affected are not well known. In addition, the sampling strategy is obtained from secondary sources and since the analysis focuses on the impact of the intervention in a region or known population group the sample is not nationally representative. The methodology requires collecting field information regarding how different groups will be affected by the intervention, the extent of influence of these groups on its success and the stakeholder perspectives. In addition to these qualitative data, quantitative information on income, expenditures, behavioural responses, coping mechanisms and other variables relevant to the study are also collected in the field. For further reading see Guimaraes, 2001.

CHAPTER 7
SCENARIO ANALYSIS FOR TSETSE AND TRYPANOSOMIASIS INTERVENTION

This section describes different tools used to carry out scenario analysis to assess the environmental, economic and social impacts of T&T interventions. These tools are qualitative and quantitative and fall into three broad categories:

- Participatory method: a qualitative approach to estimate the impacts of interventions on the environmental, economic and social systems based on a series of meetings with various stakeholders.
- Integrated quantitative models: a quantitative approach to estimate the consequences of different interventions on the environmental, economic and social systems, based on a series of assumptions and constraints related to the behaviour of the agent.
- Computer simulation: a quantitative approach to forecast the consequences of interventions at different temporal and spatial scales across environmental, economic and social systems.

This section presents selected potentially applicable tools to assess the impacts of T&T control in an integrated fashion.

7.1 Method for participatory scenario analysis

7.1.1 Participatory scenario assessment

In general, participatory methods help facilitate participation and negotiation in focus group discussions and workshops, bringing together different stakeholders. Participatory methods have the potential to bring together information from diverse sources more rapidly and cost effectively than quantitative or qualitative methods alone. These methods are very useful for investigating development processes and complex interactions between grassroots perceptions and strategies, institutions and interventions. In addition, participatory methods have a potentially useful role to assist in formation of initial hypotheses and in indicating issues to be further investigated through quantitative and qualitative impact assessment.

As a participatory tool, the private sector has used scenario analysis for the last 25 years to manage risk and develop robust strategic plans in the face of an uncertain future. It has been an informative tool to develop medium- to long-term strategic plans in the public and private sectors. Scenarios have helped public sector agencies plan for population growth and regional development, state transportation investments and the distribution of landfills. In the developing world, scenarios have been used to highlight the opportunities, risks and tradeoffs in national policy debates and in community-based forest management in the tropics, where the planning horizons are often for decades. This type of analysis is particularly useful where the management problem is complex—future projections cannot be determined from current observable trends. Therefore, this tool lends itself to situations where the future is uncertain and its application allows the analyst to prepare a set of action plans to deal with the uncertainty.

Scenario analysis is a participatory exercise based on a facilitated process of brainstorming to explore the issues of three to four plausible future situations (scenarios) in which a reform will play out. 'Scenarios' are statements that paint a broad but relatively shallow picture of possible futures. The first step in the process of scenario analysis is the identification of key issues or questions relevant to the organization(s) or project and the time frame associated with the focal issue(s). Scenarios are generated by posing 'what if' questions, for example:

- What if people change cattle breed once the T&T intervention is in place?
- What if there is no significant change in the livelihood of the poor?
- What if reinvasion rates are underestimated?

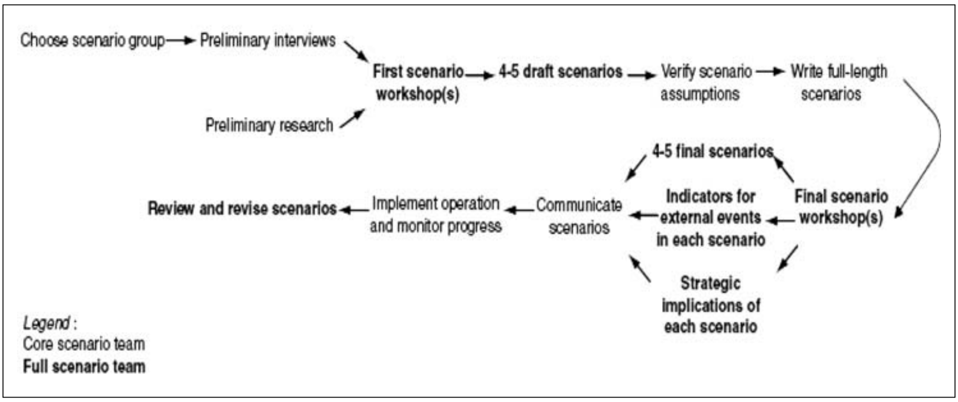
In addition, scenarios can also be generated by looking at the implications of a particular management practice based on:

1. The 'business as usual' (BAU) scenario
2. The 'best practices' (BP) scenario
3. The 'worst case' (WC) scenario

With respect to T&T control, the business as usual scenario may explore the social and economic consequences if T&T practices remained unchanged in the future or look at the social and economic consequences if eradication was completely successful (best case scenario). Often, the scenario-building process includes a small team of decision makers and selected participants from various stakeholders or a team of experts who have completed in-depth research in the problem area. In either case, no more than four or five scenarios are presented to the workshop participants. The aim is to present contrasting visions of the future for a particular problem and then systematically engage the participants to share their responses to possible scenarios and propose indicators to monitor changes (Figure 3). The scenario construction and exploration process can be carried out in single day while a participatory workshop may run over several days.

In summary, scenario analysis is a structured approach to thinking about the future. It can help decision makers develop strategic plans on how to manage risk, build consensus for change, identify new driving factors for change and identify a suite of indicators to monitor the execution of a strategy.

Figure 3. Diagram of the scenario process.



Source: From Maack, 2005.

The cost of carrying out this participatory tool can vary greatly, depending on the scope and depth of application. To train facilitators to use this tool may take 2 to 3 days. Time required for such an activity may also depend on the scope of the inquiry. There is also a need for consensus on the way to report the findings so that responses from different communities or stakeholders can be compared. For further reading see Ryan, 1994; and Shaw, 1990.

7.2 Method for integrated quantitative modelling

7.2.1 Spreadsheet models

These are analytical tools based on software programs that organize numerical data into columns and rows and using defined formulas and functions allow for calculations to take place. Spreadsheet tools are useful for calculating both ex ante and ex post analysis of disease interventions. They are commonly used in diverse types of cost–benefit analysis, policy analysis matrix and herd models, incorporating a set of specific formulas and functions for each method. The results could be non-monetary (e.g. changes in livestock population), monetary (e.g. farm income) or quantitative indicators (such as investment criteria or policy matrix coefficients). Their advantage is the ability to define one value's dependencies on other values, their ability to modify the inputs and carry out what if investigations.

However, all the calculation details are exposed in the spreadsheet and can potentially be corrupted. These calculations are stored with the input data in a single file that can be very large for complex spreadsheets. Numerous calculation sets result in numerous large files containing largely duplicate information and comparison of results from multiple modelling runs requires complex multi-spreadsheet links. In addition, spreadsheets are not designed for circular or iterative calculations. The user must design the calculations so that recycle streams are checked each time the spreadsheets calculate to ensure that a valid solution is reached.

Since spreadsheets are tools for calculation, they are commonly used to perform calculations for herd models, partial budgeting, cost–benefit analysis, policy analysis matrix and investment appraisal, so the data requirements of a spreadsheet model are based on the type of analysis to be developed. For further reading see Ryan, 1994; and Shaw, 1990.

7.2.2 Policy analysis matrix

This is a partial equilibrium framework that allows the analysis of policies in terms of their impact on commodity systems, presenting the results in a matrix of private and social values. The policy analysis matrix (PAM) can be used to assess the economic impact of adopting herd health programmes. The PAM approach requires the formation of accounting matrices for revenues, costs and profits using both private and social prices and the calculation of the transfers among rows and columns. It provides calculation of both private profitability, which represents the competitiveness of the system's technologies, and social profitability representing comparative advantages or efficiency in the commodity system. These calculations are defined as three coefficients:

- Nominal protection coefficient which indicates the net effect of distortion or a negative protection on outputs.
- Effective protection coefficient which is a measure of the net effect of distortion or negative protection on outputs and tradable inputs.
- Domestic resource cost ratio which indicates comparative advantage measured as the difference between opportunity cost of using domestic resources and the value added generated by the activity, both measured in terms of world prices.

The advantages of the methodology are its flexibility, low data requirements and clarity for presenting results to policy makers. The variables to measure are farm management, revenues and expenditures, production, animal health, extension education, quantities and prices of variable inputs, feed usage, herd inventory, milk production, health events and reproductive events. For further reading see Hall et. al., 2004; Pearson et. al., 1995.

7.2.3 Animal disease surveillance

Animal disease surveillance systems are tools for animal health-care workers that provide time series data of disease risk and incidence. These tools are used to detect either the appearance of a disease or an unusual increase in an endemic disease. The health surveillance systems are applicable at the herd and potentially the regional or national levels. The analysis can test the statistical significance of an unusual occurrence of disease. It can also test the significance of the appearance of several cases or outbreaks in a single or limited series of time periods. Alternatively, the analysis can examine the time series of data and test the significance of typically infrequent observations in a time period(s). This approach is a complement to other types of analysis and provides data for diverse decision analysis tools and simulation models. The advantage of developing an animal disease surveillance programme is that it provides practitioners with an early warning system. Once a cause-specific epidemic is identified, immediate and effective controls could be implemented, reducing the costs of the epidemic. A major limitation of the surveillance programmes is their high cost. In addition, surveillance on its own does not attempt to quantify the costs associated with correctly or incorrectly identifying the early stages of an epidemic.

The criteria needed to develop an optimal surveillance system are disease specific. It is therefore necessary to consider both costs of the disease and its control, probabilities of an epidemic occurring and its expected magnitude, before selecting the number of temporally clustered cases needed to activate the early warning. For further reading see Carpenter, 2001.

7.3 Computer simulation

7.3.1 Land use change modelling

Land use change is the result of interactions between biophysical and socio-economic processes over space and time. There is a need to understand the dynamics of land use change and be able to forecast possible responses to different kinds of interventions. Land use change models try to capture the complexity of land use systems and the modelling is an important technique for the projection of alternative pathways into the future.

Different modelling approaches have been adopted in the study of land use/land cover change. To assess current progress in this field, a workshop on spatially explicit land use/land cover models was organised within the scope of the Land use and land cover change project (LUCC). The main developments presented in this special issue concerned progress in:

- modelling of drivers of land use change
- modelling of scale dependency of drivers of land use change
- modelling progress in predicting location versus quantity of land use change
- the incorporation of biophysical feedbacks in land use change models.

Land use change models can be used to assess the impact of past and future T&T interventions on environmental and/or the socio-economic factors at a landscape or regional level. Such assessments can be helpful in determining land degradation levels and impact on biodiversity. The models of land use change have also been used to prescribe 'optimum' patterns of land use for sustainable use of land resources and development, in general. Such models are commonly used to produce land use maps which satisfy specific environmental and socio-economic constraints in planning and management contexts.

One approach to building land use models is to look at past patterns of change. This is done by applying change analysis to a set of satellite images. Such analysis, for example, can reveal where woodland has been converted to farmland. The rates of change from one land use to another are often used to project changes in area of given land use types in the future. Such rates of change often co-vary with other environmental and/or the socio-economic factors and need to be included in the model to generate reliable projections.

To develop land use models you need a team of people with diverse skills who have expertise in imaging processing, GIS, statistical modelling, Markov models, mathematical programming and optimization models. Members of the team also need to have skills in deriving a system of equations, based on quantitative findings, to model the dynamics of land use change. Finally, such a diverse team is needed not only to develop the model but also to carry out a systematic validation of projections generated from land use change models. This essential component of building land use change models is often overlooked. For further reading see Kristjanson et. al., 1999; de la Rocque et. al., 2005.; and Shaw et al. 2006.

7.3.2 GIS and economic modelling

A relatively new approach to provide insights for the decision making process for T&T interventions is the fusion of biophysical and socio-economic spatial data layers using GIS. Traditionally, GIS studies have mapped a series of ecological, demographic and socio-economic indicators, but have stopped short of mapping the distribution of a derived measure quantified in monetary units. Their approach combines economic herd models with mapping of both breed/production systems and the expansion of livestock populations under various scenarios in Benin, Ghana and Togo.

One of the goals is to model the spatial expansion of cattle populations and its economic consequences in response to different T&T interventions. This was achieved by using the estimated cattle population growth rate based on herd models for specific breed/production systems that linked trypanotolerant and susceptible cattle breeds. Using GIS data layers of existing cattle population numbers and breed/production systems, and projected growth rates from herd models it was possible to predict the future cattle population growth rate. A separate model is used to determine how 'excess' cattle populations might spread into nearby areas where grazing was available. One of the outputs of the model was to determine the spatial expansion of the cattle population and to help quantify the potential benefits of the removal of trypanosomiasis from areas into which new cattle populations would migrate.

In addition to mapping the spread of the cattle population, the model allows the mapping of the economic benefits of T&T interventions in terms of potential dollar benefits from the removal of trypanosomiasis throughout the region of the study. By comparing the model projections based on the business as usual scenario with that of the removal of trypanosomiasis throughout the region, the method allowed the mapping out of regions that could potentially benefit from such an intervention.

As a tool for scenario analysis, the combination of GIS and economic modelling can be very informative for developing plans for regional development. However, mapping economic benefits using existing and derived GIS layers requires high-resolution spatial data of good quality. Other data requirements include economic information (including standard economic projections), demographic information and relevant sector specific information in the form of GIS layers. Unreliable GIS layers, such as cattle population density and maps of tsetse distribution, are some of the limitations to this approach. However, with reliable GIS layers this modelling approach of combining demographic variables with projection of economic benefits is a unique way to map the consequences of various T&T intervention. For further reading see Kristjanson et. al., 1999; de la Rocque et. al., 2005.; and Shaw et al. 2006.

7.3.3 Geographic information systems (GIS)

These are computer based information systems that enable a researcher to capture, manage, manipulate, analyse and present geographically referenced data. GIS tools are useful for both ex ante and ex post analysis of disease interventions to identify and prioritize areas for T&T control. GIS provides information about the current and future number and density of cattle raised under trypanosomiasis risk by agro-ecological zone and tsetse status, and potential changes in animal disease and tsetse abundance because of environmental changes. This information is used to evaluate the economic impact of potential tsetse control and eradication projects or other animal disease related interventions. The advantages of using GIS are the capacity to manipulate spatial data and link geographically referenced data to tabulated data, easy visualization of information and high capability to develop models and scenarios. The variables to evaluate in a GIS based analysis depend on the specific research questions. Previous studies have needed the following data:

- tsetse distribution data layer
- cattle density data layer
- maps of agro-ecological zones
- geo-referenced data: rainfall
- temperature
- vapour pressure deficit
- vegetation cover
- elevation
- potential evapotranspiration
- length of growing period
- human population
- number of tsetse species present.

Additional data may be needed depending on the requirements of the specific method used. For predictive analysis historical data are needed while for economic analysis, geo-referenced economic data are needed. For further reading see Kristjanson et. al., 1999; de la Rocque et. al., 2005.; and Shaw et al. 2006.

CHAPTER 8
CONSIDERATIONS FOR THE SELECTION OF TOOLS

This section presents the different tools for the environmental, economic, social and integrated impacts assessment of T&T interventions. These tools have distinct requirements for their application in terms of human skills, monetary resources and time necessary to perform the analysis. Considering the constraints of the institutions or practitioners, distinct tools can be selected to assess the impacts at a given level of analysis.

The considerations for the selection of tools for environmental impact assessment are presented in Figure 4.1 below. The tools are classified based on i) the levels of analysis, i.e. individual, population, community, ecosystem, landscape and ii) the level of requirement of human, money and time resources needed. The different tools are presented in a Cartesian plane with the level of analysis in the X-axis and the required resources in the Y-axis. Thus, the available tools for environmental impact assessment range from tools to assess impacts at the individual level with low cost and low required level of skills such as counting or scoping tools, to more costly, time consuming and high requirement human skills tools to assess the impact at landscape level such as remote sensing and GIS analysis.

The considerations for the selection of tools for economic impact assessment are presented in Figure 4.2 The tools are classified based on i) the disease cost and the levels of analysis, i.e. herd, farm/household, national/international and ii) the level of requirement of human, money and time resources needed. The different tools are presented in a Cartesian plane with the level of analysis in the X-axis and the required resources in the Y-axis. Thus, the available tools for economic impact assessment range from tools to assess impacts at the herd level with low cost and low required level of skills such as gross marginal analysis or partial budgeting tools, to more costly, time consuming and high requirement human skills tools to assess the impact at national/international such as computable general equilibrium models.

The considerations for the selection of tools for the economic valuation of environmental impacts are presented in Figure 4.3. The tools are classified based on i) the market levels, i.e. conventional markets, surrogate markets and constructed markets and ii) the implied behaviour, i.e. based on potential or stated behaviour or actual or revealed behaviour. The different tools are presented in a Cartesian plane with the market levels in the X-axis and the implied behaviour in the Y-axis. Thus, the available tools for economic valuation of environmental impact range from tools to assess impacts at revealed behaviour in conventional markets to stated behaviour in constructed markets.

The considerations for the selection of tools for social impact assessment are presented in Figure 4.4. The tools are classified based on i) the levels of analysis, i.e. beneficiary, stakeholders and society and ii) the level of requirement of human, money and time resources needed. The different tools are presented in a Cartesian plane with the level of analysis in the X-axis and the required resources in the Y-axis. Thus, the available tools for social impact assessment range from tools to assess impacts at the beneficiary level with low cost and low level of skills required such as beneficiary assessment, to more costly, time consuming and high requirements for human skills tools to assess the impact at society level such as social impact analysis.

The considerations for the selection of tools for integrated impact assessment and scenario analysis are presented in Figure 4.5. The tools are classified based on i) the type of analysis, i.e. participatory method, integrated quantitative models and computer simulations and ii) the level of requirement of human, money and time resources needed. The different tools are presented in a Cartesian plane with the type of analysis in the X-axis and the required resources in the Y-axis. Thus, the available tools for integrated impact assessment range from participatory methods with low cost and low level of skills required such as participatory impact assessment, to more costly, time consuming and high requirements for human skills tools based on computer simulations such as land use change modelling.

Figure 4.1 Considerations for the selection of tools for environmental impact assessment

TIME/MONEY/SKILLS					
					• Remote sensing
HIGH					• GIS
				• Map overlays	
			• Analysis of chemical pollutants		
				• Soil analysis	
		• Capture recapture	• Time series counts		
MEDIUM			• Transect		
			• Fogging		
	• Toxicity analysis				
			• Startigraphic correlations		
		• Transects	• Quadrats		
	• Scoping	• Trapping		• Water analysis	
LOW	• Counting		• Sweep netting		• Cropping systems analysis
					• Land tenure analysis
				• PRA	
	Individual	**Population**	**Community**	**Ecosystem**	**Landscape**
	LEVELS				

Figure 4.2 Considerations for the selection of tools for economic impact assessment

TIME/MONEY/SKILLS				• Computable general equilibrium models
				• Partial equilibrium models (single sector and multi-market models)
HIGH				
				• Input-output and social accounting models
			• Simulation techniques	
				• Economic surplus
		• Investment appraisal		
MEDIUM				
	• Longitudinal monitoring	• Dynamic Herd Models		
				• Cost–benefit analysis
	• Lost potential		• Optimization approaches	
		• Break even analysis		
		• Partial budget		
LOW	• Before and after			
	• Case control	• Decision analysis		
	• Control expenditure	• Gross margin		
	• Slopes comparison			
	Disease cost	**Herd**	**Farm/household**	**National/International**
	LEVELS			

Figure 4.3 Considerations for the selection of tools for economic valuation of environmental impact

IMPLIED BEHAVIOUR				
Based on potential or stated behaviour	• Productivity method		• Contingent valuation	
	• Damage cost			
	• Avoided cost		• Contingent choice	
	• Replacement cost			
Actual or revealed behaviourstated behaviour				
		• Hedonic pricing		
		• Travel cost		
	• Market price			
	Conventional markets	**Surrogate markets**	**Constructed markets**	**MARKET LEVEL**
	LEVELS			

Figure 4.4 Considerations for the selection of tools for social impact assessment

TIME/MONEY/SKILLS			
HIGH			
			• Social impact analysis
MEDIUM			• Social capital assessment
		• Stakeholder analysis	
LOW	• Poverty diagnostics and dynamics assessment	• Participatory appraisal	
	• Beneficiary assessment		
	Beneficiary level	**Stakeholder level**	**Society level**
	LEVELS		

Figure 4.5 Considerations for the selection of tools for integrated impact assessment and scenario analysis

TIME/MONEY/SKILLS			
			• GIS and economic modelling
HIGH			• Land use change modelling
		• Animal disease surveillance	
		• Policy analysis matrix	
MEDIUM		• Spreadsheet models	
LOW			
	• Participatory scenario assessment		
	Participatory method	**Integrated quantitative models**	**Computer simulation**
	LEVELS		

CHAPTER 9
CONCLUSIONS

This document gives an overview of the different methods and tools for assessing the impact of T&T interventions on environmental, economic and social systems. It also presents selected tools used to perform integrated impact assessment considering the impacts across systems at different spatial and temporal scales.

These guidelines are designed to provide donors, development agencies and policy makers with a series of tools to undertake the challenges of assessing impact assessments in a more comprehensive and systematic approach than is currently the case.

The document presents the problem of trypanosomiasis as a constraint to development in Africa, discusses the links between the ecological, economic and social systems and the methodological challenge of assessing the impacts of T&T interventions considering the existence of direct and indirect effects across systems. The document also presents selected issues that analysts need to consider in the design and implementation of impact assessment studies and provides a brief overview of some of the methods and tools used to undertake the different levels of analysis. In addition, the guide presents some tools for integrated impact assessment and scenario development, leading to a better understanding of the impacts. Finally, the document synthesizes some considerations for the selection of appropriate tools for impact assessment for different systems and levels of analysis.

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APPENDIX 1

TABLES ON METHODS FOR ENVIRONMENTAL IMPACT ASSESSMENTS

A. Methods for environmental impact assessments at individual level

TABLE A1. COUNTING

Method/tool name	**Method/tool name**
What is it?	What is it?
What can it be used for?	To study the non-target insects affected by the intervention either at individual or community level. It is mainly used to analyse direct impacts of T&T intervention. It can also be used to assess impacts of T&T interventions on wildlife (large animals).
What does it tell you?	Helps identify biodiversity components indicative of impacts of different T&T interventions. Can tell the types of animals directly affected by the intervention, displaced due to indirect impacts or introduced because of changes following the interventions.
Complementary tools	Inventory tools
Advantage	Accurate in developing checklists of affected organisms. Easy and quick to do. Provides a quick diagnostic of the affected organisms.
Limitations	Limited for use in quantifying the impacts.
Variables to measure	All biodiversity components likely to be affected by the intervention.
Requirements	
Skills	Low
Time	Low
Financial cost	Low
Supporting software	Low
References	Adis (1979) Wathern (1986)

TABLE A2. SCOPING

Method/tool name	**Scoping**
What is it?	Random walks within the intervention areas to determine affected organisms or habitat characteristics.
What can it be used for?	Used to make an inventory of affected organisms or habitat characteristics immediately after the intervention. Useful for ex post analysis of interventions and comparing with baseline data can give a first impression of the impacts.
What does it tell you?	Organisms and habitat characteristics that are directly affected by the intervention. It links a list of possible effects with specific actions and project activities.
Complementary tools	Sampling
Advantage	Quick, can account for impacts on a wide range of organisms and habitat types.
Limitations	Is usually qualitative.
Variables to measure	■ Individual organisms (dead, misplaced etc.). ■ Habitat characteristics, e.g. ecosystem degradation, soil erosion, water pollution etc..
Requirements	
Skills	Low
Time	Low
Financial cost	Low
Supporting software and information	Check lists and inventories of organisms in the study area Baseline data information Soil colour charts Literature
References	Kent and Cooker (1992). Wathern (1986).

TABLE A3. CHEMICAL TOXICITY ANALYSIS	
Method/tool name	**Chemical toxicity analysis**
What is it?	A technique to analyse chemical toxicity in individual organisms.
What can it be used for?	Used to analyse how chemicals used in T&T control affects non-target organisms. Can be used to design mitigation strategies for reducing or avoiding effects of chemicals on the environment. Can be used to decide whether to use chemicals in T&T interventions in a particular area or not depending on the magnitude of the effects.
What does it tell you?	Tells which organisms are affected by the chemicals used in T&T interventions. Can be used to show how certain chemicals used in T&T interventions affect the environment and at what doses the chemicals can be used.
Complementary tools	
Advantage	Shows effects of using chemicals at individual organism level. Results can be replicated in other places and countries where similar organisms and habitat characteristics occur. Can be used to justify specificity of certain chemicals to target organisms and the doses that are non-lethal to organisms of interest to other sectors of economy, e.g. fish and rare or endangered species.
Limitations	Requires specialized laboratories and skills to analyse chemical toxicity. Same chemical may behave differently in different habitats (e.g. soil types) or different environmental conditions (e.g. wind velocity, rainfall regimes).
Variables to measure	■ Relationships of the chemical levels to thresholds ■ Behavioural changes in organisms due to chemical effects ■ Mortality, growth and reproduction
Requirements	
Skills	High
Time	High
Financial cost	High
Supporting software	Threshold models for specific organisms Laboratory analysis procedures and equipment
References	Linthurst et al. (1995). Sheehan et al. (1984).

B. Methods for environmental impact assessment at population level

TABLE B1. TRANSECTS

Method/tool name	**Transects**
What is it?	A framework to sample the composition and distribution of fauna and flora and variation in abiotic characteristics in a given habitat or in the intervention area.
What can it be used for?	To assess effects of T&T interventions on species composition, distribution and abundance (biodiversity). Provides a random sampling technique for statistical presentation of the composition, distribution and abundances.
What does it tell you?	Gives estimates of impacts in a sample population which can be interpolated to understand the effects in the entire population.
Complementary tools	Quadrat analysis
Advantage	Gives data that can be used qualitatively or quantitatively. The method can be used in large geographic areas. Can be used to sample a wide range of organisms and environmental parameters.
Limitations	Requires all organisms to be identified and counted. Needs replicate samples to increase reliability of the sample population as a representative of total population.
Variables to measure	■ Species types and numbers present ■ Variability of ecological or environmental states along the transect ■ Any other variable able to influence species distributional behaviour
Requirements	
Skills	High
Time	Medium
Financial cost	Medium
Supporting software and information	Computer random number generator Spreadsheet for data recording
References	Maitima and Olson (2001). Kent and Cooker (1992).

TABLE B2. TRAPPING

Method/tool name	**Trapping**
What is it?	A systematic way of sampling a population by capturing a representative sample by trapping
What can it be used for?	Used to analyse the composition, distribution and abundance of members of a mobile population. Trapping techniques can be used to test the effects of T&T interventions on selected non-target organisms or the effects of land use change on specific organisms.
What does it tell you?	Gives estimates of impacts in a sample population which can be interpolated to understand the effects in the entire population.
Complementary tools	Catching
Advantage	Gives data that can be used qualitatively or quantitatively. The method can be used in large geographic areas. Can be used to sample a wide range or organisms by varying trapping techniques and apparatus.
Limitations	Requires all organisms to be identified and counted. Needs replicate samples to increase reliability of the sample population as a representative of total population.
Variables to measure	■ Species types and numbers present ■ Variability of ecological or environmental states along the transect
Requirements	
Skills	Medium
Time	Medium
Financial cost	Medium
Supporting software and information	Computer random number generator Spreadsheet for data recording
References	Adis (1979). Hill et al. (1955). Magurran (1988).

TABLE B3. CAPTURE MARK RELEASE RECAPTURE	
Method/tool name	**Capture mark release recapture**
What is it?	This is a technique that uses marked individuals of a species to estimate their absolute densities in a habitat.
What can it be used for?	To estimate the population of certain species in a given habitat.
What does it tell you?	Can be used to show impacts of T&T interventions on a particular species of insects.
Complementary tools	Trapping
Advantage	Focuses on a single species Can be used to show changes in absolute densities
Limitations	Dependent of finding marked individuals in the second or subsequent sampling.
Variables to measure	■ Counts of individual catches
Requirements	
Skills	Medium
Time	Medium
Financial cost	Medium
Supporting software and information	
References	Andrewartha (1970). Southwood (1978).

C. Methods for assessing environmental impacts at community level

TABLE C1. FOGGING	
Method/tool name	**Fogging**
What is it?	It is a technique that is used to sample arboreal invertebrates
What can it be used for?	To study effects of an intervention on arboreal invertebrates and other tree canopy dwelling organisms.
What does it tell you?	Tells the invertebrate biodiversity in the arboreal layers of vegetation.
Complementary tools	Catching or observations
Advantage	Simple and applies to all invertebrates and other small organisms.
Limitations	Samples the organisms that are present at the time of fogging only.
Variables to measure	■ Types and numbers of individual organisms collected.
Requirements	
Skills	Medium
Time	Medium
Financial cost	Medium
Supporting software and information	Baseline data on arboreal invertebrates Spreadsheets
References	Grant (1989). Lambert et al. (1991).

TABLE C2. SWEEP NETTING

Method/tool name	**Sweep netting**
What is it?	A technique for sampling insects in a grassland ecosystem.
What can it be used for?	To study the composition of insects in a grassland ecosystem. Can be used in baseline data surveys and assessing the impacts of T&T interventions on insect fauna.
What does it tell you?	Gives the types of insects dwelling or visiting on the ecosystem. Tells the composition of insect species and their numbers on the ecosystem. Can be used to study impacts of T&T interventions by comparing the data collected before and after the intervention.
Complementary tools	Catches and field observation.
Advantage	Quick and widely used. Requires very little financial input.
Limitations	Not very accurate with flying insects. Needs to be replicated many times to get a sample that represents a population or a community. Requires a specialist to identify the insects.
Variables to measure	■ Insect types and numbers per catch.
Requirements	
Skills	Medium
Time	Low
Financial cost	Low
Supporting software and information	Baseline data on insect fauna in the area of assessment Software packages for spreadsheets and statistical analysis
References	Andrewartha (1970). Southwood (1978).

TABLE C3. QUADRATS	
Method/tool name	**Quadrat**
What is it?	A technique to sample organisms at random or in stratified order.
What can it be used for?	To survey presence or absence of plant species and other non- or less mobile members of animal biodiversity (e.g. small mammas, reptiles and amphibians). In assessments, the technique can be used to sample the above organisms and by comparing with baseline data impacts can be determined.
What does it tell you?	Tells the organisms present and their distribution across the samples. Can be use to analyse impacts of T&T interventions on species composition and abundance
Complementary tools	Plot sampling
Advantage	A quick method. Can be used to sample many species together. Can be applied to both plant and selected animal species.
Limitations	Different vegetation forms require different sizes of quadrats. Requires all species sampled to be identified by respective experts in the field.
Variables to measure	■ Species types numbers present in the quadrat.
Requirements	
Skills	High
Time	Medium
Financial cost	Medium
Supporting software and information	
References	Maitima and Olson (2001). Kent and Cooker (1992).

TABLE C5. TIME SERIES COUNTS	
Method/tool name	**Time series counts**
What is it?	A technique used to sample birds.
What can it be used for?	To survey bird species for developing baseline data. Can also be used to sample birds in assessing impacts after T&T interventions.
What does it tell you?	It tells the types of birds (species) present in an area and the abundance of each species. Effects on bird species distribution and composition following an intervention.
Complementary tools	Bird counts
Advantage	Quick to do.
Limitations	Requires skills in identifying bird species.
Variables to measure	■ Bird types by their names ■ Time of observation ■ Numbers of birds seen together ■ Habitat on which the bird was observed
Requirements	
Skills	High
Time	Low
Financial cost	Medium
Supporting software and information	
References	Pomeroy (1991). Pomeroy and Tengecho (1986a). Pomeroy and Tengecho (1986b).

TABLE C6. STRATIGRAPHIC CORRELATIONS	
Method/tool name	**Stratigraphic correlations**
What is it?	A technique for sampling micro-organisms in the soil and raising soils for profile analysis.
What can it be used for?	To study effects of T&T interventions on soil organisms. Can be used to study impacts of interventions on soil structure.
What does it tell you?	Can show if T&T interventions have impacts on soil organisms and soil structure.
Complementary tools	Observation
Advantage	Can sample organisms below soil surface. Can be used to test bio-accumulation of substances in the soil.
Limitations	Samples only a small area but if several cores are raised from a large area the sample can be a representative of a wider sampling area.
Variables to measure	■ Soil organisms ■ Soil structure ■ Stratigraphic changes in chemical accumulation
Requirements	
Skills	Medium
Time	Medium
Financial cost	Medium
Supporting software and information	
References	Maitima (1997) Miall (1984).

D. Methods for assessing environmental impacts at ecosystem level

TABLE D1. ANALYSIS OF CHEMICAL POLLUTION RISKS

Method/tool name	**Analysis of chemical pollution risks**
What is it?	It is a technique for identifying the potential hazards and the relative risks associated with a chemical.
What can it be used for?	To facilitate management of the risks in a manner that best protects social, cultural, political and economic benefits associated with the areas. It is an approach to guide the process of evaluating chemically contaminated areas.
What does it tell you?	Tells the ecological damage and resources potentially at risk from the use of the chemical. A description of the magnitude, duration, frequency and routes of contaminant exposure to potential receptors. Identifies the nature of the hazards associated with the contaminant(s) and quantifies the relationship between exposure stress and receptor characteristics. Integrates the exposure and hazard information by estimating the likely incidence of an effect under the conditions described.
Complementary tools	Reference to literature
Advantage	Provides good quality data for quantitative analysis.
Limitations	Need for multiple tests to provide all the information necessary to determine the extent and magnitude of environmental contamination.
Variables to measure	■ Habitat types present, critical or sensitive habitats present. ■ Species present: soil organisms; plant species; animal species Trophic webs and species interaction (potential bio-accumulation in higher animals, and potential human exposure.
Requirements	
Skills	High
Time	Medium
Financial cost	High
Supporting software and information	
References	Linthurst et al. (1995). Sheehan et al. (1984).

TABLE D2. PARTICIPATORY RURAL APPRAISAL

Method/tool name	**Participatory rural appraisal**
What is it?	A technique to gather information from local communities on the status and changes in ecosystems, biodiversity and other environmental parameters in their area.
What can it be used for?	To measure quantitative changes in an area using questionnaires, interviews, group discussions, workshops, seminars and stakeholder analysis.
What does it tell you?	Can show historical changes in the environment. Can be used to assess community impacts on environment.
Complementary tools	
Advantage	It is easy to use and convenient. It is useful in site comparisons. It can be applied to monitor change over time.
Limitations	May be subjective in weighting values of biological attributes.
Variables to measure	■ Levels of disturbance, e.g. rangeland condition, erosion and vegetation cover losses, water quality etc. ■ Biological attributes that are sensitive to human activities.
Requirements	
Skills	Low
Time	Low
Financial cost	Low
Supporting software and information	
References	Maitima and Olson (2001).

TABLE D3. SOIL ANALYSIS	
Method/tool name	**Soil analysis**
What is it?	A number of techniques to analyse impacts of T&T interventions on soil physical and chemical characteristics.
What can it be used for?	To analyse changes in physical characteristics and chemical composition in soils.
What does it tell you?	Tells the impacts of T&T interventions on soil quality and soil fertility and soil productivity.
Complementary tools	Plant growth analysis
Advantage	Soil analysis laboratories are readily available. Information of soil characteristics is available from many local and international organizations.
Limitations	Soil sampling and laboratory analysis can be expensive depending on the number of samples to be analysed.
Variables to measure	■ Soil physical characteristics (e.g. particle sizes) ■ Soil chemical composition (e.g. nitrogen, phosphorus and potassium)
Requirements	
Skills	Medium
Time	Medium
Financial cost	High
Supporting software and information	
References	Stocking and Murnaghan (2001). Lal and Stewart (1995). Lal et al. (1998).

TABLE D4. WATER ANALYSIS

Method/tool name	**Water analysis**
What is it?	A number of techniques to analyse physical and chemical properties of water.
What can it be used for?	To assess impacts of T&T interventions on water quality and quantity.
What does it tell you?	Tells how the interventions affect water resources and the organisms living in it. Can tell how the usefulness of the water to people and livestock is affected by T&T interventions. Can tell how changes associated with T&T interventions are affecting water availability for all production purposes.
Complementary tools	Observation
Advantage	Provides statistical measurements that can be monitored over time. Can generate data and information on which mitigation activities can be developed.
Limitations	Requires specialists in sampling of water. Specific laboratories for analysis.
Variables to measure	■ Water chemistry ■ Water physical characteristics ■ Biological organisms in the water
Requirements	
Skills	High
Time	High
Financial cost	High
Supporting software and information	
References	Maitima and Olson (2001).

E. Methods for environmental impact assessment at landscape level

TABLE E1. LAND TENURE ANALYSIS	
Method/tool name	**Land tenure analysis**
What is it?	Land tenure analysis is a technique to study changes in the ownership and access to land.
What can it be used for?	To assess changes in ownership of land by individuals, gender, age groups, ethnicity, income groups etc. as a result of land changing value due to T&T interventions. To assess changes in accessibility to land or common resources on land such as water, grazing areas and forest resources.
What does it tell you?	Can tell whether land made available for production purposes by T&T interventions is accessible to the poor communities (the target groups) or not. Can provide information relevant in formulation of land use polices at local and regional levels.
Complementary tools	Analysis of government documents
Advantage	It complements and corroborates other methods of evaluating the value of land. Easy visualization of information. Creates models and scenarios.
Limitations	Land ownership may be a sensitive issue in some communities and thus records may be inaccurate.
Variables to measure	■ People who own land and by how much. ■ The time ownership of the land. ■ Information on whether inherited, acquired or given free. ■ Data on who has the rights to natural resources in the area. ■ Incidents of conflicts of interest in access to land and land resources.
Requirements	
Skills	Low
Time	Low
Financial cost	Low
Supporting software and information	
References	Maitima and Olson (2001).

TABLE E2. CROPPING SYSTEMS	
Method/tool name	**Cropping systems analysis**
What is it?	It is a technique for analysing changes in the types of crops planted and the nature in which they are planted (either mono-cropped or mixed cropping).
What can it be used for?	To measure impacts of T&T interventions on farming systems (amount of land under fallow, land management practices and sources of seeds). To assess impacts on crop production, e.g. relative areas planted with non-consumption cash crops and relative areas planted with subsistence crops.
What does it tell you?	Can tell how T&T interventions affect crop production. Can show how presence of livestock affects crop production like in use of manure and draft power
Complementary tools	Observation.
Advantage	Provides detailed local statistics on changes in many aspects of crop production. Involves communities in a participatory approach thus likely to influence production positively.
Limitations	
Variables to measure	■ Farm management practices ■ Types of crops planted and acreage for each crop ■ Livestock feed sources and usage ■ Sources of seeds
Requirements	
Skills	Medium
Time	High
Financial cost	Medium
Supporting software and information	
References	Maitima et al. (2003). Nagel (1995).

TABLE E3. REMOTE SENSING	
Method/tool name	**Remote sensing**
What is it?	It is a technique for analysing changes in the land use and land cover from satellite imagery and air photos using remote sensing.
What can it be used for?	To measure impacts of T&T interventions on land use and land cover at landscape level. To assess impacts of T&T interventions on land cover (areas under different vegetation types, fallow, cultivated and non-cultivated areas)
What does it tell you?	Can tell how T&T interventions affect the choice of how to use the land. Can show how changes in land use affect land cover.
Complementary tools	Observation.
Advantage	Provides detailed statistics on changes in all aspects of land cover. Data can be generated retrospectively by analysing images or air photos taken earlier or in past years. Can be out scaled to wider geographical areas.
Limitations	
Variables to measure	■ Land classes ■ Spatial coverage ■ Structural characteristics
Requirements	
Skills	High
Time	Medium
Financial cost	Medium
Supporting software	Remote sensing software
References	Woodwell (1984). Lillesand and Kiefer (1987). di Gregorio (2003).

TABLE E4. MAP OVERLAYS	
Method/tool name	**Map overlays**
What is it?	A technique for overlaying a set of maps of project effects, or environmental characteristics or themes that describe the project area.
What can it be used for?	To produce a composite characterization of regional environment.
What does it tell you?	Thematic map overlays can aid in identifying geographic areas of particular environmental sensitivity and can visually provide clues to possible incremental and cumulative effects. It is valuable in mapping distributional information of migratory, vulnerable, endemic and rare species, and modelling change scenarios.
Complementary tools	GIS tools Spreadsheets
Advantage	Traceable explanation for eliminated areas. Easy to use. Development of scenarios and evaluation of different interventions. Flexibility. Models can be linked with other tools.
Limitations	Unacceptable characteristics may be mapped. The results are dependent on model assumptions. Complex model that requires large amounts of data for calibration.
Variables to measure	■ Spatial and temporal variability in species density, distribution, ranging and migratory patterns. ■ Population structure including age, sex and group structures, mortality, birth rate etc.
Requirements	
Skills	High
Time	High
Financial cost	Medium
Supporting software	
References	Bisset (1987).

TABLE E5. GEOGRAPHIC INFORMATION SYSTEMS	
Method/tool name	**Geographic information systems**
What is it?	Transparent maps with environmental and social information superimposed.
What can it be used for?	To evaluate the impact of control programmes for trypanosomiasis outbreaks or epidemic diseases.
What does it tell you?	Analysis describes complex spatial interaction in an explicit manner, identifying hotspots. Area suitability is indicated by shading intensity.
Complementary tools	Map overlays
Advantage	Defines spatial extent of impacts. Does not have to be mapped information. Can give exact rates of subtle variations. Minimizes concerns. It is robust. Can use data generated from other models.
Limitations	For mapping there are limits on the number of overlays (criteria) that can be used.
Variables to measure	■ The events over which the decision maker has control (alternatives). ■ The probability of occurrence of chance events. ■ The value of various outcomes (normally expressed in monetary terms). Multiplying the probability of occurrence of an event (such as the death of an animal), by its value, yields the expected value of the outcome. Decision analysis involves the construction of pay-off tables or decision trees, where the net benefit of each path through the tree is identified at the terminal branch. Sensitivity and threshold analyses are later performed to establish the point beyond which the original decision would not be reversed.
Requirements	
Skills	High
Time	High
Financial cost	Medium/High
Supporting software	
References	Gu et al. (1999). Woodwell (1984). Lillesand and Kiefer (1987).

APPENDIX 2

EXPLANATIONS ON THE APPLICATION OF TOOLS FOR ASSESSING ECONOMIC IMPACTS

A. Tools for assessing economic impacts of disease control applications

TABLE A1. LONGITUDINAL MONITORING

Tool name	**Longitudinal monitoring**
What is it?	A technique to evaluate the impact of trypanosomiasis on animal productivity.
What can it be used for?	Ex post analysis of interventions, when data for different years are available for the same location.
What does it tell you?	The productivity losses as a result of disease which can be monetarized using market values. Animals are grouped by the number of times they are detected parasitaemic and productivity parameters are compared for groups detected parasitaemic different number of times. The results of the analysis are the productivity loses as consequence of disease, which can be monetarized using market values.
Complementary tools	Control expenditures Control expenditures, case control comparison (parasitaemic versus non-parsitaemic, high versus low challenge sites) and/or before and after an intervention.
Advantage	Accuracy. Seasonal and inter-annual variations of animal productivity are considered.
Limitations	High cost. Large number of animals must be monitored every month for a number of years. The results might ignore considerations of what components of the losses can be realistically reduced. No references to externalities are issued.
Variables to measure	■ Birth rate ■ Weight gain ■ Milk offtake ■ Abortion rate ■ Sales, purchase, Slaughter, etc. ■ NB: What variables are included depend on what you are analying. In some production systems weight gain isn't that important
Requirements	
Skills	Medium
Time	High
Financial cost	High
Supporting software	
References	Rowlands et al. (1995) ITC (1997). Falla et al. (1999).

TABLE A2. CASE-CONTROL APPROACH	
Tool name	**Case-control approach**
What is it?	A technique to evaluate the impact of trypanosomiasis on animal productivity.
What can it be used for?	Ex post analysis of interventions when cross-sectional data for different locations are available.
What does it tell you?	The productivity losses because of disease which can be monetarized using market values.
Complementary tools	Control expenditure
Advantage	Productivity indicators are measured for entire herds rather than for individual animals, diminishing the impact of outliers.
Limitations	Difference in management and local conditions may affect the evaluation of the disease effects. The results might ignore considerations of what components of the losses can be realistically reduced. No references to externalities are issued.
Variables to measure	■ Birth rate and mortality of young animals ■ Weight gain ■ Milk offtake ■ Abortion rate
Requirements	
Skills	Medium
Time	Medium
Financial cost	Medium
Supporting software	
References	Feron et al. (1987). Ahmedin and Hugh-Jones (1995).

TABLE A3. BEFORE AND AFTER APPROACH

Tool name	**Before and after approach**
What is it?	A technique to evaluate the impact of trypanosomiasis on animal productivity.
What can it be used for?	Ex post analysis of interventions when data for the same herd within the same location are available.
What does it tell you?	The productivity losses due to disease, which can be monetarized using market values.
Complementary tools	Control expenditure
Advantage	Since the analysis is done for the same location, less environmental bias is expected.
Limitations	Management changes can occur as part of or after the treatment, affecting the straightforward evaluation of the disease effect. The results might ignore considerations of what components of the losses can be realistically reduced. Only captures the value of the remaining disease not yet controlled, while missing the value of the disease that has already been successfully avoided. For cross-sectional studies some seasonal effects or inter-annual variation could affect the assessment. No references to externalities are issued.
Variables to measure	■ Birth rate and mortality of young animals ■ Weight gain ■ Milk offtake ■ Abortion rate
Requirements	
Skills	Medium
Time	Medium
Financial cost	Medium
Supporting software	
References	Gemechu et al. (1997). Kamuanga et al. (1999).

TABLE A4. SLOPES COMPARISON	
Tool name	**Slopes comparison** (Usually based on 2 cross-section surveys, can be before and after or case-control or both)
What is it?	A technique to evaluate the impact of trypanosomiasis on animal traction.
What can it be used for?	Ex post analysis of interventions when data for cultivated area and oxen number are available for regions with different trypanosomiasis incidence.
What does it tell you?	Average area cultivated is plotted against the number of oxen owned for group of households within and outside trypanosomiasis control areas. Comparison of the two slopes provides a measure of the relative inefficiency of oxen in the two areas.
Complementary tools	Rapid appraisal methods Community-based methods
Advantage	Easy data sampling. Average cultivated area is measured for the existing oxen rather than for individual animals.
Limitations	Differences in household management, total available land and terrain characteristics could bias the results. The method assumes that households can share oxen with the neighbours.
Variables to measure	■ Area of cultivated land ■ Oxen numbers
Requirements	
Skills	Low
Time	Low
Financial cost	Low
Supporting software	
References	Swallow (2000).

TABLE A5. CONTROL EXPENDITURES	
Tool name	**Control expenditures**
What is it?	A technique to evaluate the impact of trypanosomiasis in the enterprise output as a consequence of changes in the variable costs of the farm.
What can it be used for?	Ex ante analysis of intervention when data for current expenditure in drugs are available.
What does it tell you?	This approach provides a broad measure of the avoided costs, the money saved by farmers if trypanosomiasis is controlled.
Complementary tools	Longitudinal monitoring or cross-sectional studies, Case-control and/or before and after comparisons
Advantage	Direct monetary values. The method can be used to larger geographic areas.
Limitations	Need a clear cost structure to avoid bias since some variable costs are linked to the cost of the treatment, otherwise the results might ignore considerations of what components of the expenditure can be realistically reduced. When extrapolated to larger areas, other variables should be important to consider before aggregating the data.
Variables to measure	■ Cost of the treatment (curative and prophylactic) ■ A clear cost structure of the farm ■ Any other variable able to influence the farmers' use of drugs
Requirements	
Skills	Medium
Time	Medium
Financial cost	Medium
Supporting software	
References	Geerts and Holmes (1998). van den Bossche et al. (2000).

TABLE A6. LOST POTENTIAL, REVENUE FOREGONE	
Tool name	**Lost potential, revenue foregone**
What is it?	It is a conceptual framework developed to make explicit the effect of disease in the farmer's production possibilities and the changes in the production possibilities frontier as a consequence of disease interventions.
What can it be used for?	The tool can be used to evaluate the economic consequences of production and management constraints, as a result of the level of infection prevalence and disease incidence in a region.
What does it tell you?	The analysis quantifies the economic differences between the farmer's outputs in the current situation with disease, where low productivity indigenous cattle are preferred and few draught cattle are kept, and a new situation with lower disease risk where a different set of production factors such as cattle genotypes developed for higher productivity traits such as milk and meat could be used, provided other disease problems such as tick-borne disease can be dealt with. An increase in the number of animals used for draught is another potential indirect effect as is the movement of indigenous herds into new, now tsetse-free areas where their productivity will be enhanced by the availability of better pastures.
Complementary tools	Economic surplus Partial budgeting
Advantage	The approach makes evident that after disease interventions production systems change.
Limitations	The estimation of lost potential lacks accuracy. The levels of adoption of new production factors are uncertain. The approach considers changes in the supply of the commodity but under the assumption that the prices are unchanged if combined with an economic surplus model. . Local environmental conditions and management practices can influence the outputs of high productivity cattle breeds. The approach focuses on financial returns and does not consider the societal benefits of conservation indigenous genetic resources.
Variables to measure	■ Adoption level ■ Commodity prices ■ Commodity offtake ■ Cost of new production factors
Requirements	
Skills	Medium
Time	Medium
Financial cost	Medium
Supporting software	
References	Hoste (1987). Perry and Randolph (1999).

B. Methods for assessing economic impacts at herd level

TABLE B1. GROSS MARGINAL ANALYSIS

Tool name	**Gross marginal analysis**
What is it?	It is a technique used to evaluate the economic viability of an enterprise when quantitative enterprise data are available and farmers are primarily motivated by profit maximization.
What can it be used for?	To compare enterprises and assess enterprise productivity changes at herd level as a consequence of disease interventions.
What does it tell you?	This analysis is based on actual records and because fixed costs are ignored, the problem of assigning these costs to enterprise is avoided. The result from a gross marginal analysis is commonly expressed in monetary terms or as output per standard unit, in order to be compared between different alternatives.
Complementary tools	Enterprise budget
Advantage	Fixed costs are avoided. Gross margins can be generated from on-farm records or from standard reference books.
Limitations	Limited applicability for smallholder farming systems, since for them financial return is not the only criteria for enterprise selection. Gross margin analysis should only be used as a comparative tool if the analyst fully understands both the farming systems for which the gross margins have been derived.
Variables to measure	
Requirements	
Skills	Medium
Time	Medium
Financial cost	Medium
Supporting software	
References	Rushton (1999).

TABLE B3. PARTIAL BUDGET	
Tool name	**Partial budgeting, single time period cost analysis**
What is it?	It is a technique used for within herd analysis to establish the economic impact of the disease. The results do not show the profit or loss of the farm as a whole but the net increase or decrease in net farm income resulting from proposed changes.
What can it be used for?	Partial budgets are appropriate for analysis of endemic diseases or for retrospective analysis of disease outbreaks. To test the viability of introducing a new drug against trypanosomiasis or tsetse control measure.
What does it tell you?	Partial budget is used where costs and benefits both accrue within a single year, and only the items changed by the proposal action need to be considered in the analysis. This technique is concerned with four basic elements: new costs, revenues foregone, costs saved and new revenues. The result of a partial budget analysis is expressed as change in income.
Complementary tools	Investment appraisal Cost–benefit analysis
Advantage	Simplicity: It is an easy form of budgeting analysis.
Limitations	Technical feasibility of the proposed changes. The analysis only assesses the areas of the enterprise that are affected by the change being considered, and thus can only be used to consider changes that can be isolated from the rest of the enterprise. The budgets are based on expected values and do not incorporate risk or uncertainty. The technique compares enterprises in steady state, and ignores the time taken to reach that state, the time value of money is thus assumed to be zero.
Variables to measure	■ New costs ■ Revenue foregone ■ Costs saved ■ New revenues
Requirements	
Skills	Medium
Time	Medium
Financial cost	Medium
Supporting software	
References	Kamau et al. (2000).

TABLE B4. DECISION ANALYSIS	
Tool name	**Decision analysis**
What is it?	It is a method used to evaluate issues where the probability of particular outcomes is used to weight the economic consequences should that outcome occur.
What can it be used for?	To evaluate the impact of control programmes for trypanosomiasis outbreaks or epidemic diseases.
What does it tell you?	Decision analysis describes complex economic problems in an explicit manner, identifying the available courses of action, assessing the value and probability of possible outcomes and then making a calculation to estimate the value of each possible course of action.
Complementary tools	Partial budget Cost–benefit analysis Investment appraisal
Advantage	The expected results are not necessarily expressed in monetary units, which can be an advantage in smallholder farming systems. Decision analysis combined with investment appraisal is useful where the frequencies of disease outbreak are unknown. Outputs from the investment appraisal can be used as the outcome values.
Limitations	The general technique ignores the time value of the money.
Variables to measure	■ The events over which the decision maker has control (alternatives) ■ The probability of occurrence of chance events ■ The value of various outcomes (normally expressed in monetary terms) Multiplying the probability of occurrence of an event (such as the death of an animal), by its value, yields the expected value of the outcome. Decision analysis involves the construction of pay-off tables or decision trees, where the net benefit of each path through the tree is identified at the terminal branch. Sensitivity and threshold analysis are later performed to establish the point beyond which, the original decision would not be reversed.
Requirements	
Skills	Medium
Time	Medium
Financial cost	Medium/High
Supporting software	@RISK
References	Gu et al. (1999).

TABLE B5. INVESTMENT APPRAISAL	
Tool name	**Investment appraisal**
What is it?	It is a technique to examine the impact of a change in disease over a number of years with a flow of cost and benefits at the herd level.
What can it be used for?	To examine how proposed changes in health management and treatment will affect the output of the livestock system under study.
What does it tell you?	Investment appraisal uses three decision making criteria: net present value, internal rate of return and the benefit–cost ratio, to compare the present values of benefits and costs of the proposal. Each of these criteria has strengths and weakness, so the results of the analysis are commonly presented with the three measures of project worth.
Complementary tools	Herd models Cost–benefit analysis Lost potential
Advantage	The technique takes account of the time involved for a system to reach a steady state and of the time value of the money.
Limitations	It is a deterministic approach. Lacks a component to consider the probability of occurrence of a disease outbreak or the success of a treatment or control strategy.
Variables to measure	■ Identify all benefits and the time the benefits occur ■ Identify all costs and the time the costs occur
Requirements	
Skills	Medium
Time	Medium
Financial cost	Medium/High
Supporting software	
References	Savvides (1994).

TABLE B6. DYNAMIC HERD MODEL	
Tool name	**Dynamic herd model**
What is it?	A technique to evaluate the impact of trypanosomiasis on herd productivity.
What can it be used for?	Ex ante analysis of disease interventions focused on changes in animal productivity over time, when data to calibrate the model are available and analysis of the effect of alternative strategies is desired.
What does it tell you?	The common outputs of a herd simulation model are the changes in herd size and structure and herd productivity over a defined period. Most of the herd simulation models are linked with some sub-models to calculate productivity efficiency or economic returns and the subsequent simulation results could be expressed as output/input, e.g. animals/hectare or monetary values.
Complementary tools	GIS tools Economic surplus Spreadsheets
Advantage	Development of scenarios and evaluation of benefits and costs of different interventions. Flexibility. Herd simulation models can be linked with other tools.
Limitations	The results are dependent on the model assumptions. Complex model that requires large amounts of data for calibration.
Variables to measure	The variables are model dependent, basically consider: ■ Initial herd size ■ Birth rate ■ Mortality rate ■ Net offtake More complex models could require data for herd structure in terms of age and sex, and sex and age specific mortalities and offtakes. When linked with other tools to assess economic impact, the economic variables to measure are dependent on the selected economic tool.
Requirements	
Skills	High
Time	High
Financial cost	Medium
Supporting software	
References	Shaw, et. al., (1994); Shaw, A. P. M. (1990)

C Methods for economic impacts assessment at farm or household level

TABLE C1. OPTIMIZATION APPROACHES

Tool name	**Optimization approaches**
What is it?	It is a set of mathematical techniques that provides the solution to a problem within a farming system, which is optimal with respect to a set of objective and constraints functions.
What can it be used for?	To assess the impact of disease and disease control at household, sector and national levels. To assess how a general decision maker will react to a change in a disease related variable.
What does it tell you?	The result of the optimization provides information regarding the optimal allocation of finite resources to obtain the highest output for the objective function which represents the priorities of the manager of the farming system.
Complementary tools	Simulation techniques Participatory approaches
Advantage	The approach can be expanded for multiple objectives or multiple criteria decision analysis.
Limitations	The structure of an optimization model does not allow easy adaptation to different farming systems. The assumption that an optimal solution can be found implies that all relevant data are available. The effectiveness of the approach depends on the appropriate specification of the objectives of various stakeholders. The use of the optimization model as a predictive tool requires the assumption that the objective function will remain unchanged over time. This approach is often thought to be too complex and too demanding of data to be readily applicable.
Variables to measure	The optimization model requires the specification of an objective function and constraints, which in turn require specific data collection and analysis to produce a valid objective function.
Requirements	
Skills	High
Time	High
Financial cost	High
Supporting software	
References	Kobayashi et al. (2005). Habtemariam et al. (1984). Stott et al. (2003).

TABLE C2. SIMULATION TECHNIQUES

Tool name	**Simulations and systems analysis**
What is it?	Simulation models are an abstract representation of particular facets of reality built for specific purposes, e.g. to evaluate the impact of trypanosomiasis on human welfare.
What can it be used for?	It is a method used in cases where the issue is complex and the economic implications of an erroneous decision are substantial. The development and use of epidemiological-economic models considers more closely the nature of the problem and interactions among various effects.
What does it tell you?	The simulation models are computer-based mathematical tools operating upon input data to produce output data which resembles the reality. The simulation models are built mainly for predictive purposes and their prediction capacity can be used for many different purposes.
Complementary tools	Herd simulation models
Advantage	The simulation models are especially useful in systems that cannot be solved or investigated by optimization methods, systems which contain many subsystems that cannot easily be controlled and studied simultaneously, systems which cannot be subject of experimentation or that involve highly dynamic relationships over many time periods. Simulation models are highly flexible.
Limitations	Very expensive and time consuming. Data shortages and model assumptions can have serious consequences on model outputs.
Variables to measure	Case dependent
Requirements	
Skills	High
Time	High
Financial cost	High
Supporting software	
References	Muller et al. (2004).

D. Methods for assessing economic impacts at national and international levels

TABLE D1. COST–BENEFIT ANALYSIS

Tool name	**Cost–benefit analysis**
What is it?	It is a method to compare the costs and benefits that arise from programmes and interventions in animal health, in terms of their societal welfare effects in more than one time period.
What can it be used for?	To compare and contrast different strategies for disease control, especially long-term programmes at a national or regional level. To analyse interventions, where the actions of one livestock owner affect the welfare of others, or external costs are imposed.
What does it tell you?	Whether a project is feasible.
Complementary tools	
Advantage	Comprehensiveness, the method is easy to understand and intuitive. The method incorporates the time value of money. The cost–benefit analysis includes economic, environmental, biological and medical effects.
Limitations	Data requirements are high.
Variables to measure	■ Productivity impacts ■ Costs and prices ■ Elasticities ■ Adoption data ■ Discount rate ■ Environmental valuation of impacts
Requirements	
Skills	Medium
Time	Medium
Financial cost	Medium
Supporting software	
References	Politi et al. (1995). Kamuanga (2003).

TABLE D2. ECONOMIC SURPLUS	
Tool name	**Economic surplus**
What is it?	It is a technique to assess the economic impacts of change in the supply and demand of a commodity. These changes can result from the use of an animal disease control method or animal management technique in a specific geographic area.
What can it be used for?	To assess economic impacts of animal disease control technologies at regional, national and international levels. To quantify the impact that changes in animal health have for both the producers and consumers of the commodity.
What does it tell you?	Economic surplus methods are based on the premise that changes in animal health have an effect on the supply of the commodity or commodities being produced. Analysis takes place to estimate the shift in the supply and the changes in the price paid for the commodity by consumers in society. The analysis can be made ex post by collecting appropriate data or ex ante using expert opinion.
Complementary tools	GIS
Advantage	Flexibility. A framework that can be extended to national and international levels.
Limitations	Large data requirements. High level of effort to collect, process and analyse economic and technical data.
Variables to measure	■ Productivity impacts ■ Costs and prices ■ Elasticities ■ Adoption data ■ Discount rate
Requirements	
Skills	High level of analytical skills
Time	High
Financial cost	High
Supporting software	
References	Kristjanson (1999). Ott et. al. (1995).

TABLE D3. INPUT-OUTPUT AND SOCIAL ACCOUNTING MODELS	
Tool name	**Input-output and social accounting models**
What is it?	I-O and SAMs are multi-sector models that summarize the economic transactions in an economy.
What can it be used for?	To compute the impacts of various types of exogenous shocks such as disease outbreaks on the performance of diverse sectors in the economy. I-O model follows the flow of inputs into the livestock sector from every other sector in the economy (e.g. services, agriculture and manufacturing) and the flow of outputs from the livestock sector to each of these other sectors. SAMs include the distribution of factors of production (land, labour and capital) to households and other institutions in addition to the productive sectors found in the I-O.
What does it tell you?	Changes in outputs are calculated through simulations that alter the level of final demand. The method shows how a one unit change in demand for meat exports would be transmitted throughout the economy, in terms of changes in the production in each sector. Different disease effects could be simulated by adjusting final demand in the livestock sector as suggested by an epidemiological model or an assumed exogenous shock.
Complementary tools	Partial equilibrium models
Advantage	Ability to capture linkages between economic sectors
Limitations	I-O models do not allow for changes in prices and are unable to consider dynamic changes in a sector over time. The changes in the economy are due to shifts in the demand curve rather than from supply constraints.
Variables to measure	An input-output table will be constructed by aggregating into broad groups different sectors in the economy Sales made from a given sector to each of the other sectors in the economy should be recorded. Information about consumption, investment and net exports are also required.
Requirements	
Skills	High
Time	Medium
Financial cost	Medium
Supporting software	Implant
References	Garner and Lack (1995). Caskie et al. (1999). Mahul and Durand (2000).

TABLE D4. PARTIAL EQUILIBRIUM MODELS

Tool name	**Partial equilibrium models (single sector and multi-market models)**
What is it?	Partial equilibrium models define functional relationships for supply and demand of a specific commodity in a specific time and place. Supply and demand are represented as mathematical functions that constitute constraints in an optimization framework.
What can it be used for?	To analyse agricultural policy, international trade and environmental issues. To estimate national or aggregate impacts of disease. To measure changes in prices, links across markets or changes in welfare.
What does it tell you?	Interpretation of partial equilibrium models requires a basic understanding of the development and meaning of supply and demand functions within the context of a given system. Changes in the equilibrium prices and quantities can be used to derive changes in producer and consumer surpluses.
Complementary tools	Cost–benefit analysis GIS
Advantage	Can be conducted with respect to one sector (single sector models) or multiple sectors (multi-market models)
Limitations	Data requirements can be substantial
Variables to measure	■ Productivity impacts ■ Costs and prices ■ Elasticities ■ Adoption data ■ Discount rate
Requirements	
Skills	Medium
Time	Medium
Financial cost	Medium
Supporting software	
References	Rich (2004). Schoenbaum and Disney (2003). Mangen and Burrell (2003). Paarlberg et al. (2002).

TABLE D5. COMPUTABLE GENERAL EQUILIBRIUM MODELS

Tool name	**Computable general equilibrium models**
What is it?	In terms of modelling the economic effects of animal disease this is an approach that combines input-output and multi-market models to represent the effects of disease on the entire economy.
What can it be used for?	To address questions concerning impacts across sectors, categories of households and employment groups. To address changes in prices, the reallocation of labour and capital markets and longer-run impacts.
What does it tell you?	The model provides information about how a shock in the economy such as an animal disease outbreak would transmit throughout all sectors of the economy and the potential reverberations on national income trade and employment.
Complementary tools	Input-output model Partial equilibrium
Advantage	Potentially gives a larger amount of information than other models
Limitations	Expensive. The interpretation of results can be problematic. Is dependent on the level of aggregation.
Variables to measure	■ Sales made from a given sector to each of the other sectors in the economy ■ Information about consumption, investment and net exports ■ Productivity impacts ■ Costs and prices ■ Elasticities ■ Adoption data ■ Discount rate
Requirements	
Skills	High
Time	High
Financial cost	High
Supporting software	
References	Perry et al. (2003). Blake et al. (2002).

E. Methods for economic evaluation of environmental impacts of trypanosomiasis interventions

TABLE E1. MARKET PRICE METHOD

Tool name	**Market price method**
What is it?	A tool for assessing the impact of disease interventions on the society, valuing the changes in quantity or quality of several ecosystem goods or services that are bought and sold in commercial markets (e.g. fish, timber and fuel wood) based on the quantity people purchase at different prices, and the quantity supplied at different prices.
What can it be used for?	To quantify in monetary terms some of the direct or indirect impacts of animal health interventions on natural systems based on the direct use value of several goods and services whose quantity or quality has been altered with the intervention.
What does it tell you?	The method provides the value of the economic losses due to the intervention as the sum of lost consumer surplus and lost producer surplus.
Complementary tools	Productivity method
Advantage	Standard, accepted economic techniques. People's values are likely to be well defined. Price, quantity and cost data are relatively easy to obtain for established markets. Uses observed data of actual consumer preferences.
Limitations	Markets are available for only a limited number of goods and services and may not reflect the value of all productive uses of a resource. Has limitations assessing changes that affect the supply of or demand for a good or service. Market imperfections and/or policy failures could mean that the true economic value of goods or services may not be fully reflected in market transactions. May overstate benefits since the market value of other resources used to bring ecosystem products to markets are not deducted. Seasonal variations and other effects on price must be considered.
Variables to measure	■ Consumer surplus, which requires estimates of the demand function. ■ Demand function, which requires data on the quantity demanded at different prices, plus data on other factors that might affect demand, such as income or other demographic data. ■ Producer surplus, which requires data on variable costs of production and revenues received from the good.
Requirements	
Skills	
Time	
Financial cost	
Supporting software	
References	Ko et. al. (2004).

TABLE E2. PRODUCTIVITY METHOD	
Tool name	**Productivity method**
What is it?	A tool to estimate the direct or indirect impact on society of disease interventions that generate changes in the quantity or quality of ecosystem goods and services that are factors of production for commercially marketed goods.
What can it be used for?	The method is convenient in cases where the ecosystem goods and services are used, along with other inputs, to produce a marketed good. Changes in the quantity or quality of these goods and services (e.g. changes in water quality, soil quality) may generate changes in production costs and/or productivity of other inputs. This in turn affects the price and/or quantity supplied of the final good and may also affect the economic returns to other inputs.
What does it tell you?	Considering that changes in quality or prices of the final good will affect consumer surplus and changes in productivity or production cost will affect producer surplus, then changes in the economic surplus will provide an estimate of the economic value of environmental impacts.
Complementary tools	Simulations models
Advantages	The method is easy to understand and intuitive. Data requirements are limited. Relevant data may be readily available or obtained from simulation models, making the method relatively inexpensive to use.
Limitations	The method does not measure the value of non-marketed environmental goods and services; hence the inferred value may understate the true impact value to society. Some lags in temporal and spatial effects since changes in productivity associated with environmental effects may take a long time to become apparent to farmers, thus scientific understanding of the relationships between the changes and productive outcomes are needed.
Variables to measure	■ Costs of production of final good ■ Supply and demand data for final good ■ Supply and demand data for other factors of production
Requirements	
Skills	
Time	
Financial cost	
Supporting software	
References	Kumar and Rao (2001). Barbier (2000).

TABLE E3. HEDONIC PRICING

Tool name	**Hedonic pricing method**
What is it?	A tool to estimate the direct or indirect impact on society of disease interventions that generate changes in the quantity or quality of an ecosystem good or services, under the premise that market prices reflect environmental and non-environmental attributes and consumer behaviour can be revealed through surrogate markets.
What can it be used for?	To estimate in monetary terms the economic impact of programmes or projects that generate changes in environmental quality such as air, water or noise pollution, or changes in environmental amenities, such as aesthetic views, through the differences in market prices of real estates in areas with different environmental impacts, after controlling for other attributes. The coefficients of the model can be used to determine the implicit price associated with some environmental characteristics, holding all other factors constant
What does it tell you?	Since the hedonic pricing method is designed to control for certain non-environmental attributes, then the remaining value differentials of the real estate can be surrogated values of the non-priced environmental goods and services. Hedonic functions for the price of a real estate considering a vector of environmental and non-environmental characteristics are estimated. The surrogate values of the non-priced environmental goods and services. The hedonic functions for the price of real estate considering a vector of environmental and non-environmental characteristics.
Complementary tools	Productivity change Contingent valuation
Advantages	Based on current choices. Flexible enough to be adapted to many different situations, since data on real estate prices are reliable, available from many sources and property markets are relatively efficient and competitive.
Limitations	The surrogate markets capture only the direct consequences of changes in environmental quality that affect the price of real estate properties assuming that users can perceive the differences in environmental quality and, given their income, can select the combination of features that prefer. Many sources of market distortions. Results are influenced by model specification. The complexity of the analysis. The time and expense to carry out an application depends on the availability and accessibility of data.
Variables to measure	■ Cross-section and/or time-series data on real estate properties values and property ■ Household characteristics for a defined market area that includes different levels of environmental quality ■ Prices for real estate to value changes in quality or quantity of environmental goods or services in competitive markets
Requirements	
Skills	
Time	
Financial cost	
Supporting software	
References	Latouche et al. (1998). le Goffe (2000).

TABLE E4. TRAVEL COSTS	
Tool name	**Travel cost method**
What is it?	A surrogate market tool to estimate the direct or indirect impact on society of disease interventions that generates changes in the quantity or quality of ecosystems or sites that are used for recreation.
What can it be used for?	To estimate in monetary terms the economic use values associated with ecosystems or sites that are used for recreation. To estimate the economic benefits or costs resulting from animal disease interventions that generate environmental impacts such as changes in environmental quality or costs of access to a recreational site, or elimination or creation of a recreational site. To evaluate the effect of animal disease intervention on tourism activities.
What does it tell you?	The basic idea of the method is derive a demand curve from data on actual travel costs, under the premise that the time and travel cost expenses that people incur to visit a site represent the 'price' of access to the site. Analogous to estimate peoples' willingness to pay for a marketed good based on the quantity demanded at different prices, the travel cost method estimates people's willingness to pay to visit the site based on the number of trips that they make at different travel costs. Using survey data, the demand curve for the average visitor, i.e. the relationship between number of visits and travel costs and other relevant variables, can be specified. The area below this demand curve gives the average consumer surplus, which is multiplied by the total relevant population to estimate the total consumer surplus for the site. People's willingness to pay to visit a site based on the number of trips they make at different travel costs. The total consumer surplus for a site.
Complementary tools	Contingent valuation Choice modelling
Advantages	Relatively inexpensive to use. Based on users' current decisions rather than stated preferences. Results are relatively easy to interpret and explain because the method uses commonly employed techniques to estimate economic values based on market prices.
Limitations	The method cannot be used to measure non-use values or off-site values provided by the natural system and is only suitable for goods and services recognized by the users, since the method assumes that people's behaviour to travel cost changes is similar to their response for price changes in other markets. The method is not useful to estimate ex ante effects of interventions that potentially change environmental conditions. In order to apply the method, a high level of user collaboration is needed. Several problems defining and measuring the opportunity cost of the time spent travelling, the effect of substitute destinations and multi-purpose trips can bias or overestimate the results. In addition, the method is sensible to the approach and functional form used to estimate the demand curve and the choice of variables included in the model.
Variables to measure	The data requirements depend of the approach: ■ Secondary data and simple data collected from visitors for zonal travel cost ■ An individual travel cost approach will require a more detailed survey of visitors ■ More complicated statistical techniques such as a travel cost using random utility approaches will need more extensive surveys and complementary data Generally, data regarding the origin of the visitors to estimate the distance travelled, the number of visits in a defined period of time, the number of days involved in the trip, the reasons for the travel, and the time spent at the site and other destines is collected. In addition, travel expenses, income and some socio-economic characteristics of the visitor, data regarding potential substitute destinations and perceptions of environmental quality at the selected site are collected.
Requirements	
Skills	
Time	
Financial cost	
Supporting software	
References	Turpie and Joubert (2001). Font (2000).

TABLE E5. DAMAGE COSTS, AVOIDED COSTS, REPLACEMENT COST AND SUBSTITUTE COST METHODS	
Tool name	**Damage cost, avoided cost, replacement cost and substitute cost methods**
What is it?	A set of methods to provide estimates of the economic impact of animal disease interventions on the environment, by quantifying the value of ecosystem goods or services based on the costs of avoiding damages, purchasing substitutes or replacing the altered functions provided by natural systems. The methods are developed under the common assumption that since people incur costs to avoid damage or to replace or provide substitutes for ecosystem goods or services then those services must be worth at least what people paid to replace them, avoid the damage or acquire a substitute. However, these estimates do not represent the people's willingness to pay for the products or service, and the method does not provide strict measures of economic values.
What can it be used for?	To assess the economic impact of animal disease interventions that directly or indirectly affect the capacity of natural systems to provide goods or services for local communities. To evaluate the impacts of worsened water quality by measuring the cost of controlling effluent emissions. To evaluate erosion protection services by measuring the cost of removing sediment from downstream areas. To evaluate water purification services by measuring the cost of filtering and chemically treating water. To evaluate fish habitat and nursery services by measuring the cost of fish breeding and stocking programmes. Due to their limitations, these methodologies should be considered to be applied only after the society has indicated that the value of the goods and services provided by the environment to the affected people is greater than the estimated costs of the project (e.g. approved spending for the project). As an indirect consequence of trypanosomiasis control it is likely that in certain areas changes in land use will occur that subsequently affect the environment. These methodologies can also be used to evaluate the impacts of worsened water quality by measuring the cost of controlling effluent emissions; evaluating erosion protection services by measuring the cost of removing sediment from downstream areas; evaluating the water purification services by measuring the cost of filtering and chemically treating water; or evaluating fish habitats and nursery services by measuring the cost of fish breeding and stocking programmes.
What does it tell you?	The monetary value of the costs incurred by people to avoid damage, replace or provide substitutes for ecosystem goods or services should represent a rough estimate of the value of those services.
Complementary tools	
Advantages	Provide at least a rough measure of the value of ecosystem goods or services which may be difficult to value by other means when data or resource limitations make it impossible to estimate people's willingness to pay for them.

TABLE E5. DAMAGE COSTS, AVOIDED COSTS, REPLACEMENT COST AND SUBSTITUTE COST METHODS

Tool name	Damage cost, avoided cost, replacement cost and substitute cost methods
Limitations	Do not consider social preferences for ecosystem services or individual's behaviour in the absence of those services. Despite the knowledge that costs are usually not an accurate measure of benefits, these methods share the assumption that the expenditures to maintain or replace the ecosystem services are valid measures of the benefits provided. May under- or overestimate the benefits, since simplistic applications do not consider the degrees of substitution between the alternative and the natural good or service or their non-use values. Incurred costs may also serve other purposes and these external benefits are usually not considered in the analysis. The values of the alternatives to mitigate damage or avoid costs tend to be arbitrary and limited by the income, commonly not representing the social scarcity value of the resources.
Variables to measure	Information regarding the ecosystem service in terms of how it is provided, who the users are and how its level of provision was affected, collected in the field and complemented with secondary sources. Later for the damage cost method, an estimation of the potential damages in the property for a defined period of time is developed and used to calculate in monetary terms the value of the potential damage or the amount that users will spend to avoid that damage. For the replacement or substitute cost method, after collecting the initial information on how the level of provision was affected, identify the least costly alternative means of providing the service and then calculate the cost of the substitute or replacement service.
Requirements	
Skills	
Time	
Financial cost	
Supporting software	
References	Holl and Howarth (2000).

TABLE E6. CONTINGENT VALUATION	
Tool name	**Contingent valuation (CV)**
What is it?	A tool used to estimate economic values of all kind of ecosystem goods and services. It can be used to estimate both use and non-use values and it is the most widely used method for estimating non-use values. It is also the most controversial of the non-market valuation methods.
What can it be used for?	The contingent valuation method involves directly asking people, in a survey, how much they would be willing to pay for specific environmental services. In some cases, people are asked for the amount of compensation they would be willing to accept to give up specific environmental services. These studies can be used in ex ante or ex post to estimate mostly non-use values and non-market use values of environmental goods and services.
What does it tell you?	In economic terms, the contingent valuation method estimates the Hickisian consumer surplus—either the compensating variation or the equivalent variation—due to changes in the provision of public goods.
Complementary tools	
Advantages	Flexible, able to estimate use and non-use values and ex ante and ex post assessments. Can estimate use values, and existence values, option values, and bequest values.
Limitations	Results have a series of biases focused on two different aspects: validity (accuracy) and reliability (reproducibility). The validity refers to the capacity of CV to measure the true economic values and includes content, criterion and construct validity. Reliability requires that in repeated measurements, the true value of the phenomenon does not change or if the true value has changed, the measure with a reliable method will change accordingly. Several other sources of error are consequences of embedding, sequencing, information and elicitation effects and hypothetical and strategic bias. The method has some reliability problems which are assessed testing for convergent validity or testing-retesting methods.
Variables to measure	■ The specific variables to measure and include in the questionnaire will necessarily be case dependent. However, reference operating conditions have been formulated: ■ Respondents should be familiar with the goods or services being evaluated ■ The payment vehicle should be realistic ■ Use dichotomous choice formats ■ Include specific questions to minimize part-whole problems ■ Include theoretical validation testing
Requirements	
Skills	
Time	
Financial cost	
Supporting software	
References	Bayoumi (2004). Scarpa et al. (2003).

TABLE E7. CONTINGENT CHOICE

Tool name	**Contingent choice**
What is it?	A tool used to estimate both use and non-use values (similar to contingent valuation); however, this method does not directly ask people to state their values in monetary terms. Instead, values are inferred from the hypothetical choices or tradeoffs that people make. Also called conjoint analysis.
What can it be used for?	To measure preferences for different characteristics or attributes of a multi-attribute choice. Because it focuses on tradeoffs among scenarios with different characteristics, contingent choice is especially suited to policy decisions where a set of possible actions might result in different impacts on natural resources or environmental services. Thus, it is particularly useful in valuation of improvements to ecosystems, given that several service flows are often simultaneously affected. To evaluate improvements to ecosystems given that several service flows are often simultaneously affected. To rank options without focussing on monetary value.
What does it tell you?	The contingent choice method asks the respondent to state a preference between one group of environmental services or characteristics, at a given price or cost to the individual, and another group of environmental characteristics at a different price or cost.
Complementary tools	
Advantages	Values outcomes of an action as a whole as well as the various attributes or effects of the action. Allows respondents to think in terms of tradeoffs between alternatives. Estimates the relative values or priorities of users, providing valid information for policy decisions.
Limitations	Lack of familiarity of respondents with some tradeoffs hinders the evaluation. Some biases may appear due to the complexity of choices or their high number. A limited number of choices can also represent a source of error because it may force respondents to make choices that they would not voluntarily make. Translating the choices to monetary values is not a simple process and the validity and reliability of the method for valuing non-market commodities is largely untested.
Variables to measure	
Requirements	
Skills	
Time	
Financial cost	
Supporting software	
References	Werder (2004). Gyrd-Hansen (2004). Hall et al. (2004). Hall et al. (2002). Mallawaarachchi et al. (2001). Rolfe et al. (2000).

APPENDIX 3
METHODS FOR SOCIAL IMPACTS ASSESSMENTS

A. Methods for social impact assessments at beneficiary level

TABLE A1. BENEFICIARY ASSESSMENT	
Tool name	**Beneficiary assessment**
What is it?	A qualitative research tool to evaluate and monitor human and animal health projects based on participatory assessment and direct consultation of those affected by and influencing the interventions.
What can it be used for?	To develop ex post analysis of reforms and monitor the impact of human and animal health interventions when transmission channels and affected groups are clearly defined. It can be used as an ex ante tool to evaluate proposed reforms, identify constraints and receive feedback from beneficiary stakeholders.
What does it tell you?	The results of the assessment provide information on the perception beneficiaries have of the problem, their reception to the project and the positive and negative effects of the implementation of trypanosomiasis interventions.
Complementary tools	Stakeholder analysis Institutional analysis Models
Advantages	Less resource intensive than other tools to evaluate social impact. Some quantitative analysis could be developed with the beneficiary feedback.
Limitations	The method provides low contextual and historical background information.
Variables to measure	Background information on stakeholders, on cultural, ethnic, or socio-economic variations and on the variables determining whether specific groups would be affected (such as type of access). The data collection includes conversational interviews, focus group discussions and direct and participant observation.
Requirements	
Skills	Sociological or anthropological training Good knowledge of the programme Historical and cultural factors
Time	Low
Financial cost	
Supporting software	
References	Salmen (2002). Salmen and Amelga (1998). Salmen (1989).

TABLE A2. POVERTY DIAGNOSTICS AND DYNAMICS ASSESSMENT	
Tool name	**Stages of Progress analysis**
What is it?	A qualitative research tool to evaluate and monitor human and animal health projects based on participatory assessment and direct consultation of those affected by and influencing the interventions.
What can it be used for?	To develop ex post analysis of reforms and monitor the impact of human and animal health interventions when transmission channels and affected groups are clearly defined. It can be used as an ex ante tool to evaluate proposed reforms, identify constraints and receive feedback from beneficiary stakeholders.
What does it tell you?	The results of the assessment provide information on the perception beneficiaries have of the problem, their reception to the project and the positive and negative effects of the implementation of trypanosomiasis interventions.
Complementary tools	Stakeholder analysis Institutional analysis Models
Advantages	Less resource intensive than other tools to evaluate social impact. Some quantitative analysis could be developed with the beneficiary feedback.
Limitations	The method provides low contextual and historical background information.
Variables to measure	Background information on stakeholders, on cultural, ethnic, or socio-economic variations and on the variables determining whether specific groups would be affected (such as type of access). The data collection includes conversational interviews, focus group discussions and direct and participant observation.
Requirements	
Skills	Sociological or anthropological training Good knowledge of the programme Historical and cultural factors
Time	Low
Financial cost	
Supporting software	
References	Salmen (2002). Salmen and Amelga (1998). Salmen (1989).

B. Methods for assessing impacts at stakeholder level

TABLE B1. PARTICIPATORY APPRAISAL

Tool name	**Participatory appraisal**
What is it?	A set of techniques to provide a quick, systematic and cost-effective picture of livestock conditions and veterinary problems, especially in agropastoral communities.
What can it be used for?	For needs assessment and feasibility studies to identify priorities and implement and monitor interventions. Their main value lies in their ability to investigate, analyse and evaluate constraints and opportunities and make informed and timely decisions, and find practical solutions to animal health problems including the views of farmers and involving the community.
What does it tell you?	Several types of diagrams are widely used to summarise and present the information. Besides histograms, bar and pie charts and maps the most commonly used are: ■ Transects. These summarise the most important features of the different areas and ecozones, and are useful in showing spatial differences and trends. ■ Seasonal calendars. These highlight the temporal patterns of human activities, production and biological events (including diseases). These factors can also be plotted against climatic data ■ Flow diagrams and decision trees. These can present clearly the key factors which may influence decision-making and the consequences derived from such decisions or other changes.
Complementary tools	Rapid assessment methods Optimization approach
Advantages	Uncomplicated, reliable and cost-effective method for collecting information on which tsetse intervention decisions can be based.
Limitations	The presence of outsiders can influence people's behaviour. Responses may be altered to please, confuse or deceive the researchers. In group discussions and meetings, the literate and members of the elite may receive more attention than others. People may avoid openly expressing their opinions in public.
Variables to measure	Background information: Demographic data for people and animals, the role of livestock in farmers' livelihood. Disease related information and other factors affecting people's welfare. Production information: Species and breeds of livestock kept, husbandry practices and sources of feed. Gender division of labour, Average production figures and their seasonal patterns. Foods of animal origin most commonly produced, consumed or sold; main markets for livestock products. Seasonal information: Local cropping calendars. Seasonal variations in labour demand. Important festivals and seasonality of supply, demand and prices for livestock and wildlife products.
Requirements	
Skills	Medium
Time	Low
Financial cost	Low
Supporting software	
References	Ghirotti (1993). IIED (1994). Waters-Bayer and Bayer (1994). FAO (1986). FAO (1992). ILCA (1983).

TABLE B2. STAKEHOLDER ANALYSIS

Tool name	**Stakeholder analysis**
What is it?	A qualitative methodology to determine the interests and influences of the different groups involved in a project.
What can it be used for?	Ex ante and ex post analysis of structural and sectoral reforms in trypanosomiasis interventions and animal health projects. To define categories for analysis, and identify affected groups, their conflicts and influences to develop strategies for overcoming negative distributive effects.
What does it tell you?	The stakeholder analysis provides information on the potential social and political effects of the trypanosomiasis interventions and the perceptions and roles of different ethnic, religious or linguistic groups.
Complementary tools	Social impact analysis Modelling
Advantages	Simple method Low cost
Limitations	Stakeholder analysis relies on qualitative data. The absence of statistical sampling procedures obligates a careful selection of respondents and interpretation of data.
Variables to measure	Stakeholder analysis is iterative and the variables to consider are case dependent. Initially, obtaining background information on constraints to effective project implementation is required. Later, specific stakeholders from diverse groups of interests will be identified through interviews with key informants. Finally, a survey focused on community and animal health issues complemented with quantitative secondary data will be used to determine stakeholders' influences and interests.
Requirements	
Skills	Sociological or anthropological training is helpful, as is a background in political science.
Time	Low
Financial cost	
Supporting software	
References	Collins et al. (2002). Bianchi, R and Kossoudji, S. (2001)

C. Methods for impact analysis at society level

TABLE C1. SOCIAL CAPITAL ASSESSMENT

Tool name	**Social capital assessment**
What is it?	A set of integrated quantitative and qualitative methods to evaluate the role of institutions, networks and norms in the promotion of collective action.
What can it be used for?	To evaluate the importance of some proxies for social capital in collective actions related to T&T control.
What does it tell you?	The analysis will provide information about the effect of the disease in the community, the institutions and organizations, and the interests of different social groups in participating in T&T interventions. The method also indicates the importance of norms, values and group characteristics in developing their own initiatives or support or resist externally promoted interventions.
Complementary tools	Stakeholder analysis Institutional analysis Social impact analysis Beneficiary assessments
Advantages	Social capital is a multidimensional concept and the social capital assessment tool is able to capture their bonding, bridging, structural and cognitive aspects.
Limitations	Define some proxies for social capital relevant to the study to be operative. If some indexes are defined, there could be a problem of subjectivity in the weight of the involved variables.
Variables to measure	Different techniques such as surveys, key informant interviews, and focus groups will be used to obtain quantitative and qualitative information at the households, communities, and institutional levels regarding the role of organizations and their membership in aspects such as solidarity, trust, cooperation, and conflict resolution in the context of the disease interventions.
Requirements	
Skills	Sociological or anthropological training, in particular a sound understanding of formal and informal institutions and networks
Time	
Financial cost	
Supporting software	
References	Grootaert and van Bastelaer (2002). Stephens et al. (2004). Lomas (1998). Quinn et al. (2003).

TABLE C2. SOCIAL IMPACT ASSESSMENT	
Tool name	**Social impact analysis**
What is it?	An iterative framework based on detailed social information to identify and analyse the impacts and responses to animal health intervention by people and institutions.
What can it be used for?	To investigate the impacts of trypanosomiasis interventions and animal health projects on the society, especially involving the effects on vulnerable groups and the poor.
What does it tell you?	A social impact analysis provides contextual information of the social and political systems in the area of the project. The analysis identifies the different affected groups along the project development, as well as their preferences, priorities and their ability to develop coping mechanisms to mitigate negative impacts.
Complementary tools	Stakeholder analysis Institutional analysis Modelling
Advantages	Different methods are used to obtain both quantitative and qualitative data from a sample representative of a particular region or population groups relevant to a particular project. The method can be used even when national household data do not exist or do not contain the specific information needed to assess reform impacts.
Limitations	High level of knowledge of local customs and culture required to structure and interpret qualitative and quantitative data. The method has limitations when the transmission channels and groups affected are not well known.
Variables to measure	Since the analysis focuses on the impact of the intervention in a region or known population groups, the sample is not nationally representative. Detailed contextual information from relevant issues to the intervention or affected groups is obtained from secondary sources to determine the sampling strategy. Information regarding how different groups will be affected by the intervention, the extent of influence of these groups on its success and the stakeholder perspectives is collected in the field. To complement these qualitative data, quantitative information of income, expenditures, behavioural responses, coping mechanisms and other variables relevant to the study are also collected in the field.
Requirements	
Skills	A team with mixed skills
Time	Variable
Financial cost	
Supporting software	
References	Finterbusch et al. (1990). Goldman (2000). Becker (1997). World Bank (2002c). Guimaraes (2001).

APPENDIX 4
METHODS FOR INTEGRATED SCENARIO DEVELOPMENT

A. Impact assessment by participatory method

TABLE A1. PARTICIPATORY SCENARIO DEVELOPMENT	
Tool name	**Scenario analysis: Participatory method**
What is it?	A participatory exercise to explore plausible future situations (scenarios) in which a reform will be play out.
What can it be used for?	Scenario analysis is forward-looking. The process is particularly adapted to bringing the perspectives of different stakeholders together around a contentious issue. Scenarios have been used to bring community leaders, environmentalist and politicians together to help make long-term strategic plans.
What does it tell you?	This type of analysis is particularly useful where the management problem is complex—future projections cannot be determined from current observable trends. This tool lends itself to situations where the future is uncertain and its application allows to prepare a set of action plans to deal with the uncertainty. It can help to identify new interaction amongst stakeholders. It can help to generate alternative trajectories for future development.
Complementary tools	Vision scenario Projection scenario Pathway scenario
Advantages	Flexible approach Low data requirements Clear in presentation to policy makers
Limitations	It is more a descriptive method than a quantitative one.
Variables to measure	Economic information, including standard economic projections. Demographic information. Sector specific information relevant to the issues at hand.
Requirements	
Skills	Individuals in scenario-construction process should include decision-makers and people with broad range of expertise.
Time	A participatory scenario exercise is usually carried out in two to three workshops lasting several days each. Need at least a half-day for the scenario-construction process.
Financial cost	Cost of running 1–3 day workshop.
Supporting software	
References	Maack (2005). Ryan 1994; Shaw 1990.

B. Methods for integrated quantitative modelling

TABLE B1. SPREADSHEET MODELS

Tool name	**Spreadsheet models**
What is it?	Analytical tools based on software programs which organize numerical data into columns and rows and using defined formulas and functions allow for calculations to take place.
What can it be used for?	To calculate both ex ante and ex post analyses of disease interventions. Used in diverse cost–benefit analysis, policy analysis matrix and herd models, incorporating a set of specific formulas and functions for each method.
What does it tell you?	Since spreadsheets are tools for calculation, the requirements and results of a spreadsheet model are based on the type of analysis developed. The results could be non-monetary, e.g. changes in livestock population, monetary, e.g. farm income, or quantitative indicators such as investment criteria or policy matrix coefficients.
Complementary tools	Herd models Partial budgeting Cost–benefit analysis Policy analysis matrix Investment appraisal
Advantages	Easy to define one value's dependencies on other values. When an ordinary spreadsheet is fully assembled, its inputs are easy to change. You can carry out what if investigations.
Limitations	All of the calculation details are exposed in the spreadsheet and can potentially be corrupted. The calculations are stored with the input data in a single file that can be very large for complex spreadsheets. Numerous sets of calculations result in numerous large files containing largely duplicate information. Comparison of results from multiple modelling runs requires complex multi-spreadsheet links. Spreadsheets are not designed for circular or iterative calculations. The user must design the calculations so that recycle streams are checked each time the spreadsheets calculate to ensure that a valid solution is reached.
Variables to measure	The spreadsheets are tools for calculations. The variables to measure will depend of the specific analysis to be developed.
Requirements	
Skills	Medium
Time	Low
Financial cost	Low
Supporting software	
References	Ryan 1994 Shaw, 1990.

TABLE B2. POLICY ANALYSIS MATRIX

Tool name	**Policy analysis matrix**
What is it?	A partial equilibrium framework that allows the analysis of policies in terms of their impact in commodity systems, representing the results in a matrix of private and social values.
What can it be used for?	To assess the economic impact of adopting herd health programmes. The PAM approach requires the formation of accounting matrices for revenues, costs and profits using both private and social prices and the calculation of the transfers among rows and columns.
What does it tell you?	The PAM provides calculations of both private profitability, which represent the competitiveness of the systems technologies, and social profitability representing comparative advantages or efficiency in the commodity system. These calculations are defined as three coefficients: nominal protection coefficient, which indicates the net effect of distortion or a negative protection on outputs; effective protection coefficient, which is a measure of the net effect of distortion or negative protection on outputs and tradable inputs; and domestic resource cost ratio, which indicates comparative advantage measured as the difference between opportunity cost of using domestic resources and the value added generated by the activity, both measured in terms of word prices.
Complementary tools	Rapid appraisal Participatory approaches
Advantages	Flexible approach Low data requirements Clear in presentation to policy makers
Limitations	All of the calculation details are exposed in the spreadsheet and can potentially be corrupted. The calculations are stored with the input data in a single file that can be very large for complex spreadsheets. Numerous sets of calculations result in numerous large files containing largely duplicate information. Comparison of results from multiple modelling runs requires complex multi-spreadsheet links. Spreadsheets are not designed for circular or iterative calculations. The user must design the calculations so that recycle streams are checked each time the spreadsheets calculate to ensure that a valid solution is reached.
Variables to measure	■ Farm management ■ Revenues and expenditures ■ Production ■ Animal health ■ Extension education ■ Quantities and prices of variable inputs ■ Feed usage ■ Herd inventory ■ Milk production ■ Health events ■ Reproductive events
Requirements	
Skills	Medium
Time	Low
Financial cost	Medium
Supporting software	
References	Pearson et al. (1995). Hall et al. (2004).

TABLE B3. ANIMAL DISEASE SURVEILLANCE

Tool name	**Animal disease surveillance**
What is it?	Tools for animal health care workers, providing time series data of disease risk and incidence.
What can it be used for?	To detect either the appearance of a disease or an unusual increase in an endemic disease. The health surveillance systems are applicable at the herd and potentially the regional or national levels.
What does it tell you?	The analysis can test the statistical significance of an unusual occurrence of disease. They can also test the significance of the appearance of several cases or outbreaks in a single or limited series of time periods. Alternatively, they can examine the time series of data and test the significance of typically infrequent observations in a time period(s).
Complementary tools	Decision analysis Simulations Spreadsheets Community participation
Advantages	Early warning, once cause-specific epidemic is identified, immediate and completely effective controls could be implementing reducing the epidemic costs.
Limitations	High cost of surveillance. Surveillance does not attempt to quantify the costs associated with correctly or incorrectly identifying the early stage of an epidemic.
Variables to measure	The criteria necessary to develop an optimal surveillance system are disease specific. It is necessary to consider both costs of the disease and its control, probabilities of an epidemic occurring and its expected magnitude, before selecting the number of temporally clustered cases needed to activate the early warning.
Requirements	
Skills	High
Time	High
Financial cost	High
Supporting software	
References	Carpenter (2001).

C. Methods for assessing impacts by computer simulation

TABLE C1. LAND USE CHANGE MODELLING

Tool name	**Scenario analysis: Land use change modelling**
What is it?	A method to capture the complexity of land use systems and an important technique for the projection of alternative pathways into the future.
What can it be used for?	To determine the current and past spatial distribution of land use in a region and how it may change over time.
What does it tell you?	The models of land use change can be used to prescribe 'optimum' patterns of land use for sustainable use of land resources and development and are commonly used to produce land use maps which satisfy specific environmental and socio-economic constraints, in a planning and management context.
Complementary tools	
Advantages	Clear in presentation to policy makers. Historical trends are captured. Maps can be helpful identify regions of rapid change.
Limitations	Very data intensive and highly skilled people are required.
Variables to measure	
Requirements	
Skills	Imaging processing GIS Statistical modelling Markov models Mathematical programming Optimization models
Time	Six to eight person months
Financial cost	Salary for six to eight person months Range of US$ 250-400 per image.
Supporting software	Image processing software Statistical and modelling software GIS software (ESRI)
References	Lambin et al. (2000). Land-Use and Land Cover Change project (2001).

TABLE C2. GEOGRAPHICAL INFORMATION SYSTEM	
Tool name	**Scenario analysis: GIS and economic modelling**
What is it?	A modelling approach that integrates biophysical and socio-economic spatial data layers to generate economic projections which can be represented in the form of a map.
What can it be used for?	To provide insights into the decision-making process for T&T interventions by integrating bio-physical and socio-economic spatial data layers. GIS has long helped underpin economic analyses – looking at poverty, market proximity, livestock distribution among other indicators.
What does it tell you?	The model allows mapping of the economic benefits in terms of potential dollars for a particular T&T interventions.
Complementary tools	
Advantages	Clear in presentation to policy makers. Maps can be helpful to identify regions to target.
Limitations	Very data intensive and highly skilled people are required.
Variables to measure	
Requirements	
Skills	GIS Statistical modelling Mathematical programming
Time	Six to eight person months
Financial cost	Salary for six to eight person months
Supporting software	GIS software Statistical and modelling spreadsheet
References	Shaw (2006).

APPENDIX 5
TERMS OF REFERENCE FOR CONDUCTING BASELINE SURVEYS

5.1 Terms of reference for technical experts

These terms of reference are currently in use by PATTEC to collect baseline data before the interventions. The original outlines of these terms of reference were developed during a regional harmonization meeting held in Nairobi, Kenya, and attended by PATTEC Coordinators and the country teams including subject specialists. In this report we include the terms relating to environmental and socio-economic assessments to guide the PATTEC project mangers in engaging technical experts to conduct impact assessments. These terms of reference will also guide the experts to identify areas where data is to be collected in order to apply the tools described in this document.

5.1.1 Detailed terms of reference for environmental baseline survey

Background

Trypanosomiasis, a debilitating and deadly vector-borne disease of humans and livestock transmitted by tsetse flies, is a major obstacle to the socio-economic development in 37 affected sub-Saharan African countries, causing considerable human suffering, agricultural and wage losses, and food insecurity in terms of affordability and availability in tropical and subtropical areas of Africa. This disease is unique to Africa, affecting about 9 million km2 of the humid and sub-humid zones, known as the tsetse belt, and representing roughly 39% of the agricultural land in these countries. Most of the affected countries have included the T&T eradication issue in their poverty reduction strategy papers (PRSPs) under the Heavily Indebted Poor Countries (HIPC) Initiative. In recognition of the severity of the problem, African Heads of State and Government, during the Summit of the Organization of African Unity (OAU) held in Lomé (Togo) in July 2000, passed a resolution to free Africa of tsetse flies and trypanosomiasis (Decision AHG/Dec 156(XXXVI). This led to the creation within the Commission of Agriculture and Rural Development the 'Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC)' with a mandate to assist in eliminating the scourge of tsetse-transmitted trypanosomiasis from the African continent once and for all.

The ADB, PATTEC and representatives from some affected countries developed, using the

Plan of Action as a basis, a 'bankable' continent-wide programme for 'Eradication of Tsetse and Trypanosomiasis in Sub-Saharan Africa' (ETTSSA), to guide future investments in the eradication of the problem (ADF, 2004b).

Programme concept and rationale

The programme for the implementation of the PATTEC initiative shall be executed in phases, each phase involving as many projects as the available finances can support. The finances to support the implementation of projects will be derived from the affected countries, the Bank Group and other partners. The programme will be based on the principle of the area-wide approach in integrated pest management (IPM) and organized as a systematic process of suppression of tsetse flies with aim of eventually eradicating them from specific areas at a time. Surveillance, diagnosis and treatment of sleeping sickness in humans and nagana in livestock in each project area will also be undertaken. The programme will integrate all available technically feasible, cost effective and environmentally acceptable tsetse intervention methods, including tsetse trapping systems, application of insecticides (through traps, targets, ground spraying or Sequential Aerial Technique) with the Sterile Insect Technique (SIT). The strategy used to implement the programme is to systematically create zones that are T&T free, beginning with identified areas in selected countries and expanding the areas of intervention in roll-the-carpet fashion through sustained action in subsequent phases. The programme will comprise a series of projects initiated in different countries and sequential phases, where each project will be executed independently of the other, but in co-ordination with the implementation of other projects in the programme. The linkage phases between phases will create the synergy necessary to drive the programme.

Objective

The overall goal of the programme is to contribute to halving poverty by 2015 and promoting economic growth to the target 8% necessary to reduce poverty and improve food security in Africa. The primary objective of the programme is to eradicate tsetse flies from the 37 affected countries in sub-Saharan Africa and so remove the constraint on agricultural production and human productivity. As part of the implementation process, PATTEC requires the service of a consultant to undertake an environmental baseline study in the project areas in (NAME OF RESPECTIVE COUNTRY) to serve as an initial documentation of the environmental status before project implementation and upon which changes can be deciphered in the future monitoring and assessments. Specifically the survey seeks to determine the current environmental situation with regard to the general status of biotic and abiotic components in relation to agricultural production. More specifically: land use, land cover, biodiversity and natural resources base in the project areas.

Specific tasks

From a thorough review of reports from previous related work done, consolidate all available information that can contribute to the general understanding of the environmental status of the project area at the time of this study.

In consultation with project coordination and management unit (PCMU) on data capture format and management and on the appropriate time, conduct a survey or surveys to document the following:

A. An acquisition of all available maps reports on previous work done on the subject.

B. The ecological zones, land cover types/habitat patterns in the project areas.

C. The composition and distribution of vegetation types using transects and quadrants in accordance with standard sampling procedures for different vegetation categories.

D. The abundance, distribution and densities of selected animal groups (groups to be selected in consultation with PCMU), using the most appropriate sampling methods for each animal group. Surveys to include key informant interviews, questionnaires, group discussions or any other justifiable method that is acceptable to PCMU, subject specialists.

E. The composition, distribution and abundance of plant and animal species of economic importance (e.g. medicinal plants, species of conservation value etc.) in different ecological types in the project areas.

F. The soil physical characteristics (e.g. erosion potential, soil mineralization, texture etc.) in the project areas in reference to different land use and land cover types.

G. The soil and water chemical composition in different land use types and different water bodies in the project areas with special reference to those that are important to or are affected by agricultural production and water quality respectively.

H. Checklists of different biodiversity components in the project areas developed from field surveys to supplement and update information available in literature.

I. Detailed maps of current vegetation distribution, land use patterns and natural resources distribution in the project areas.

Methodology

In consultation with the PCMU:

a) Sample vegetation using at least 4 km length transects for every land use, land cover/ vegetation type.

b) Either on transects or randomly selected points sample vegetation using circular quadrats with 1-m, 5-m, 20-m diameters for herbaceous vegetation (including grass), shrubs and forests respectively.

c) For each vegetation type, land use, land cover types maintain a sampling effort of not less than 10 samples. The actual sample size to depend on extent of the area being sampled, complexity of species and the species being sampled.

d) For animal species maintain a sample size of 30% of the estimated population.

e) Maps generated should be in both digital and hard copy and should be based on verifiable data such as satellite imagery, geographic information systems (GIS) andfield surveys.

Outputs

a) Detailed report or reports containing all the specific tasks outlined in the methodology.

b) GIS map on the current land cover types in the project areas and land use types showing areas with major crop types, settlement patterns, physical infrastructure and natural resources distribution.

c) Report on the composition and status of plant and animal species of economic importance.

d) A report with a list of indicators of change in each project areas covering all measurable parameters of environmental change and how best to monitor changes or impacts in each parameter (including methods and time interval between monitoring).

e) A database of land cover (with area covers for each type), land use patterns (with area covers for major land use types (e.g. fallow, cash crops, staple foods etc.), biodiversity (with indications on abundance and conservation status where applicable) and natural resources present in the study area

f) A report on the sustainability of current land use practices, current resource uses in the area and areas of concern to environmental conservation.

Timelines

a) To be worked out in consultation with PCMU.

Location and logistics

a) The consultant and his/her team will work in collaboration with government personnel in the field for coordination, communication to the community and other logistical needs.

b) The project consultant will pay for his/her technical assistants in the field including accommodation and transportation depending on whether there are such provision in the budget. except for the government staff attached to the team who will be paid by the government or PCMU.

c) The consultant will be responsible for his own accommodation and transportation in the field.

d) The contract will include a professional fee for the consultant in addition to providing funds to cover the full costs of operations related to this consultancy.

e) PCMU will pay allowances and fees to government staff involved in the survey.

f) The consultant is expected to use his own professional tools (computers, software, field equipment etc.) and expendable resources in carrying out the surveys, data processing and preparation of the outputs.

g) The mode of payments will be agreed between the consultant and the PCMU.

Qualifications

a) Demonstrated experience in environmental baseline surveys in agricultural (including livestock) production areas.

b) Experience in carrying out baseline surveys in the tasks outlined in the methodology.

c) An established institution or environmental firm with a good mix of expertise covering a wide range of disciplines and skills as required to complete the tasks specified including good analytical skills.

d) Ability to attract high-quality and well-trained subject specialists for sub-contracting or engaging where necessary.

e) Knowledge on environmental issues associated with land use change and sustainability of agricultural production preferably in tsetse suppression areas.

f) A good and demonstrated record of delivery of high quality work.

g) Work experience in different regions of sub-Saharan Africa involving different scales of analysis.

h) Possession of adequate facilities to enable execution of the tasks specified above and outputs outlined to the highest standards.

i) Well established in GIS facilities and capabilities to analyse complex environmental issues and integration of environmental and socio-economic issues.

5.1.2 Terms of reference for socio-economic surveys

Background

Trypanosomiasis, a debilitating and deadly vector-borne disease of humans and domestic animals transmitted by tsetse flies, is a major obstacle to the socio-economic development in 37 affected sub-Saharan African countries, causing considerable human suffering, agricultural and wage losses, and food insecurity in terms of affordability and availability in tropical and subtropical areas of Africa. This disease is unique to Africa, occupying about 9 million Km2 of the humid and sub-humid zones, known as the tsetse belt, and representing roughly 39% of the agricultural land in these countries. Most of the affected countries have included the tsetse and trypanosomiasis eradication issue in their Poverty Reduction Strategy Papers (PRSPs) under the heavily indebted Poor Countries (HIPU) Initiative. In recognition of the severity of the problem, African Heads of State and Government, during the Summit of the Organization of African Unity (OAU) held in Lome (Togo) in July 2000, passed a resolution to free Africa of tsetse flies and trypanosomiasis (Decision AHG/Dec. 156(XXXVI). This led to the creation within the Commission of Agriculture and Rural Economy the “Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC)” with a mandate to assist in eliminating the scourge of tsetse-transmitted trypanosomiasis from the African continent once and for all.

The ADB, PATTEC and representatives from some affected countries (including Kenya) developed using the Plan of Action as basis a “bankable” continent-wide programme for “Eradication of Tsetse and Trypanosomiasis in Sub-Saharan Africa” (ETTSSA), which should guide future investments in the eradication of the problem (ADF 2004(b).

Programme Concept and Rationale

The programme for the implementation of the PATTEC initiative shall be executed in phases, each phase involving as many projects at a time as the available finances can support. The finances to support the implementation of projects will be derived from the affected countries, the Bank Group and other partners. The programme will be based on the principle of the area-wide approach in Integrated Pest Management and organized as a systematic process of suppression of tsetse flies with the aim to eventually eradicate tsetse flies from specific areas at a time. Surveillance, diagnosis and treatment of sleeping sickness in humans and nagana in livestock in each project area will also be undertaken. The programme will integrate all available technically feasible, cost effective and environmentally acceptable tsetse intervention methods, including tsetse trapping systems, application of insecticides (through traps, targets, ground spraying or Sequential Aerial Technique) with the Sterile Insect Technique. The strategy employed in the implementation of the programme is to systematically create tsetse-and-trypanosomiasis-free zones, beginning with identified areas in selected countries and expanding the areas of intervention in roll-the-carpet fashion through a sustained action in subsequent phases. The programme will comprise a series of projects initiated in various countries and sequential phases, where each project will be executed independently of the other, but in co-ordination with the implementation of other projects in the programme. The linkage phase between phases would create the synergy necessary to drive the programme.

Objective

The overall goal of the programme is to contribute to halving poverty by 2015 and promoting economic growth to the target 8% necessary to reduce poverty and enhance food security in Africa. The primary objective of the programme is to eradicate the tsetse flies from the 37 affected countries in sub-Saharan Africa and so remove the constraint on agricultural production and human productivity. As part of the implementation process, PATTEC requires the service of a consultant to undertake socio economic baseline studies in the project areas of the participant countries. The study seeks to collect both qualitative and quantitative data to increase the understanding of the current situation of the socio-economic and cultural settings of the communities in the project areas, providing information that will be used to make informed decisions, as well as monitor and evaluate the progress of the project towards its goal.

Specific tasks

a) Review reports of previous related work done on the impact of T&T interventions on the socio-economic and cultural systems of the communities and community participation in T&T control activities to identify suitable interventions and collect secondary data.

b) In consultation with PCMU on data capture format and management, collect geo-referenced data and conduct household surveys and community studies to:

    1. Establish indicators for future monitoring and evaluation of the project.
    2. Provide general demographic profiles of the communities (human population, education, gender, health related issues and the seasonality of both human and livestock trypanosomiasis issues).
    3. Establish existing infrastructure and services in relation to human and animal health.
    4. Determine the social organization of production.
    5. Determine the livelihood constraints of households located in the project area.
    6. Determine household income sources and average monthly expenditure.
    7. Determine the number of livestock -holding households and stock of livestock in the households including data on number, species and breeds

8. Determine the quantity of livestock products (milk, meat, manure and traction power) produced by livestock in households throughout the year.
9. Investigate the local modes of adaptation and spatial dimension of production systems.
10. Establish indigenous knowledge and management/coping mechanisms of T&T in both humans and livestock.
11. Assess trypanosomiasis prevalence and incidence in humans and livestock.
12. Establish the cost of the disease (i.e. treatment costs, transactional costs and productivity losses) for humans and livestock.
13. Establish the dominant farming system.
14. Identify factors influencing implementation of past T&T control technologies.

The consultant will:

a) Liaise with the Environmental Socio-Economic Assessment Project.

b) Liaise with the PCMU.

c) Process the collected data and provide a GIS layer with the socio-economic information collected.

d) Analyse the data and submit a final report to the National Steering Committee (NSC)

Methodology

In consultation with the PCMU, the expert will collect both quantitative and qualitative data to achieve the specific tasks defined above. The successful candidate should have proven experience in development and implementation of diverse data gathering and analysis methodologies, including:

- Cross-section surveys using structured questionnaires
- Participatory rapid rural appraisal techniques.
- Participatory epidemiological approaches.

Outputs

- GIS maps on the distribution of tsetse with socio-economic activities in the project areas.
- Detailed report on the:
  a) Current situation on the impact of T&T interventions on the socio-economic and cultural systems of the communities and community participation in T&T control activities in the project areas.
  b) Indicators for future monitoring and evaluation of the project.
  c) Information on general demographic profiles of the communities (human census, education, gender, health related issues, the seasonality of both human and livestock trypanosomiasis issues).
  d) Existing Infrastructure and services in relation to human and animal health.
  e) The social organization of production of the communities.
  f) The livelihood constraints of households located in the project area.
  g) Household's income sources and average monthly expenditure.
  h) The number of livestock-holding households and stock of livestock in the households including data of number, species and breeds.
  i) The quantity of livestock products (milk, meat, manure, traction power) produced by livestock in households throughout the year.
  j) The local modes of adaptation and spatial dimension of production systems.
  k) The indigenous knowledge and management/coping mechanisms of tsetse and both human and livestock trypanosomiasis.
  l) Trypanosomiasis prevalence and incidence in humans and livestock.
  m) The cost of disease (i.e. treatment costs, transactional costs and productivity losses) for humans and livestock.
  n) The dominant farming system.
  o) Factors influencing implementation of past tsetse and trypanosomiasis control technologies.

Timelines Discuss with PCMU

APPENDIX 6
PARTICIPANTS OF WORKSHOPS

Two workshops were held at various points in the development of this book. The first was held on 14th and 15th February 2005 and aimed at identifying the needs of individual countries in relation to evaluating the impacts of T&T interventions that the book should address. The second was held on 20th to 21st November 2006 and was aimed at getting a feed back from the stakeholders and the potential users on the draft guidelines. The following is a list of participants in the two workshops. (* indicates attendance to first workshop; # attendance to second workshop, *# attendance both workshops)

Jane RUTO #
KARI- Trypanosomiasis Research Centre
P.O. Box 362. KIKUYU, 09002
Cell: 0722 683125
Email: jjrutto@yahoo.co.uk

Sospeter Onchoke NYAMWARO *#
KARI-Trypanosomiasis Research Centre
P.O. Box 362. KIKUYU, 09002
Phone: +254 20 2700604/654
Cell: 0723 850587
Email: nyamwaro2005@yahoo.com

Francis OLOO *#
Tsecon Consultants
P.O. Box 10482-00100
NAIROBI
Phone: +254 20 247998
Cell: 0733 600672
Email: oloofp@africaonline.co.ke

Denis OUEDRAOGO #
Universite Polytechnique de Bobo
Dioulasso 01
UPB/IDR 01 BP 1091
Bobo-Dioulasso 01
BURKINA FASO

Phone: +256 20 973372
Cell +226 70 230459
Email: denisorel@gmail.com
denispcadi@yahoo.com

Moges WORKU #
Regional Environment specialist
US Embassy
P.O. Box 1014
Addis Ababa, ETHIOPIA
Phone: +517 4283
Cell: +911865986
Email: workum@state.gov

Pamela OLET *#
National Coordinator
PAATEC Kenya
P.O. Box Private Bag-00625
KANGEMI
Phone: +254-20-6750967
Cell : 0722 463000
Email polet@pattec.co.ke

Aligui DJITEYE #
National Coordinator
PAATEC Mali
P.O. Box 9125
Sotuba, BAMAKO
Phone: +233 22 1985
Cell: +233 644 8300
Email: addjiteye01@yahoo.com

Giuliano CECCHI #
Consultant for PAAT-IS
FAO-AGAH Animal production
and Health Division
Viale delle terme di Caracalla 1
00100. ROME
Phone: +39 065 7053526
Cell: +39 397 9379787
Email: giuliano.cecchi@fao.org

Julius ITHAGU – BEN #
National Environmaental
Managemaent Authority
P.O. Box 67839-00200
NAIROBI
Phone: +254 605522
Cell : 0722 666542
Email: benithagu@yahoo.com

Umar LAWAL #
African Development Bank
P.O Box 323, TUNIS
Avenue du Ghana
Tunis, Belvedere
Tunisia
Phone: +216 71102368
Cell: +216 22690296
Email: l.umar@afdb.org

Anne Marie NYAMU #
Consultant Science
Writer/Editor
P.O. Box 399-00606
Sarit centre, NAIROBI
Cell: 0733-822438
Email amnyamu@yahoo.com

Luis C. RODRIGUEZ *#
Scientist
International Livestock Research Institute
P.O. Box 30709-00100
NAIROBI
Phone: +254-20-422 4818
Email l.c.rodriguez@cgiar.org

Hemed NURU #
Senior Policy Officer
Livestock and Fisheries
AU-IBAR
P.O. Box 30786-00100
NAIROBI
Phone: +254 367 4000
Cell: 0733 523359
Email: hameed.nuru@au-ibar.org

Ahmed Abdou Ali ELSAWALHY #
AU-IBAR
Museum Hill
Westlands Road
P.O Box 30786-00100
NAIROBI
Phone: +254-20-367 4226
Cell: 254 733 749870
Email: ahmed.elsawalhy@au-ibar.org

Mrigesh KSHATRIYA **
International Livestock Research Institute
P.O.Box 30709-00100
NAIROBI
Phone: +254 20 422 3000
Email m.kshatriya@cgiar.org

Francis EJOBI #
Department of Veterinary Public Health
and Preventive Medicine
Faculty of Veterinary Medicine
Makerere University P.O Box 7062
Kampala
Phone: +256-41-586938
Cell: +256 722 492236
Email ejobi@vetmed.mak.ac.ug
or ejobifrancis@yahoo.com

Lawrence Mukasa SEMAKULA #
Co-ordinating Office For Control Of
Trypanosomiasis In Uganda
P.O Box 16345
WANDEGE YA KAMPALA
Phone: +256 41 250726
Cell: +256 722 497569
Email coctu.maaif@yahoo.com
or ldmsemakula@yahoo.com

Nuhu IBRAHIM #
Ministry of Food and Agriculture
PATTEC Project
Ghana
MOFA PPMED
P.O Box M37
ACCRA
Phone +233 21 668157
Cell: +233 24 4788920
Email nuhuibrahim@yahoo.com

Joseph MAITIMA *#
International Livestock Research Institute
P.O Box 30709-00100 NAIROBI
Tel: 422 3000 ext 4502
Email: j.maitima@cgiar.org

Simon MUGATHA *#
International livestock Research Institute
P.O Box 30709-00100 NAIROBI
Tel: 422 3000 ext 4310
Email: s.mugatha@cgiar.org

John KBAYO *
Regional PATTEC Coordinator
PO Box 200032
ADDIS ABABA
Ethiopia
Tel: 251 1 516467
Fax: 251 1 505928
Email: jkabay@hotmi.com

Assefa MEBRATE *
Pan African SIT FORUM
PO Box 1176
Department of Biology
University of Addis Ababa
ADDIS ABABA
Ethiopia
Tel: 251 9 11 234049
Email: amebrate@bio.aau.edu.et
amebrate@hotmail.com

Charles MAHAMA *
PATTEC Project Coordinator
Ghana
MOFA PPMED
P.O Box M37
ACCRA
Phone +233 21 668157
Email cimahama@yahoo.com

Dr. Freddie KANSIIME *
Deputy Director, COCTU
PO Box 16345
Kampala, Uganda
Tel: 256 41 250726/256 77 528884
Fax:
Email: COCTU@Infocom.co.ug

Daniel BALZER *
US State Department
balzerdk@state.gov
danielkbalzer@yahoo.com

David KINYUA *
REDSO/ESA/FS
Nairobi

Sadou MAIGA *
Mali PATTEC Office
Tel: 223 224 0145
Fax: 223 643 6554
Email: sadoumaiga@hotmail.com
smaiga@afriline.net.ml

Idrissa KABORE *
01 BP 454 CIRDES
Bobo-Dioulasso
Burkina Faso

Seth ONYANGO *
PAATEC Kenya
P.O. Box Private Bag-00625
KANGEMI
Phone: +254-20-6750967
Cell : 0722 463000
Email polet@pattec.co.ke

Ade FREEMAN **
International Livestock Research Institute
P.O Box 30709-00100 NAIROBI
Tel: 422 3000 ext 4502
Email: a.freeman@cgiaraorg

H. KIARA *
International Livestock Research Institute
P.O Box 30709-00100 NAIROBI
Tel: 422 3000 ext 4502
Email: h.kiara@cgiar.org

Stella MASSAWE *
International Livestock Research Institute
P.O Box 30709-00100 NAIROBI\
Tel: 422 3000 ext 4502
Email: s.massawe@cgiar.org

Tom RANDOLPH *
International Livestock Research Institute
P.O Box 30709-00100 NAIROBI
Tel: 422 3000 ext 4502
Email: t.randolph@cgiar.org

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John Kabayo
Regional PATTEC Coordinator
P.O. Box 200032
Addis Ababa, Ethiopia
Tel: 251 1 516467
Fax: 251 1 505928
Email: jkabay@hotmi.com

Temesgen Alemu
Ethiopia PATTEC Coordinator
Ethiopian Science and Technology Agency
Southern Tsetse Eradication Project
P.O. Box 19917
Addis Ababa, Ethiopia
Tel: +251-911-210428
Email: step@estc.gov.et

Lawrence Semakula
Uganda PATTEC Coordinator
P.O. Box 16545 Wandegeya
Kampala, Uganda
Tel: +256 41 250726
Email: coctu.maaif@yahoo.com
ldmsemakula@yahoom.com

Alexandra Shaw (Ms)
AP Consultants
Upper Cottage
Abbotts Ann
Andove SP11 7BA, United Kingdom
Tel: +44 (0) 1264 710238
Email: alexandrashaw@compuserve.com

Pamela Akinyi Olet
Kenya PATTEC Coordinator
Ministry of Livestock & fisheries Dev
Veterinary Department
P.O. Private Bg 00625
Kangemi
Fax: + 254 20 631273
Tel: + 254 20 632231
E-mail : Pamaolet@yahoo.com

Grace Mullira
Centre Director
KETRI/KARI
P.O. Box 362, Kikuyu
Fax: +254 66 32397
Tel: + 254 66 32922; 32960-4
E-mail: ketri2@bidii.com or
gmurilla@yahoo.co.uk

Issa Sidibé
Burkina Faso PATTEC Coordinator,
CIRDES
01 BP 454, Bobo Dioulasso
Burkina Faso
Tel: 226 972789/972053
Fax: 226 972320
Email: is.sidibe@fasonet.bf
isidibe@hotmail.comsambo@fasonet.bf

Assefa Mebrate
Chairman, S.I.T. Forum
P.O. Box 1176,
Department of Biology
Faculty of Science, Addis Ababa University
Fax: + 251 1 566552
Tel: + 251 1 234040
E-mail: amebrate@hotmail.com

Charles Ibrahim Mahama
Ghana PATTEC Coordinator
P.O. Box 97, Pong-Tamal
Tel: + 233 21 26445
Fax: + 233-21 776021
E-mail: cimahama@yahoo.com

Mr. Francis P Oloo
Director,
Tsecon Consultants,
P O Box 10482-00100,
Nairobi, Kenya.
Tel/Fax +254(020)247798,
E-mails oloofp@africaonline.co.ke
tseconsults@yahoo.com

Africa Union
Inter African Bureau for Animal Resources
Museum Hill, Westlands Rd.,
P.O. Box 30786 – 00100
Nairobi, Kenya
Tel: +254-20-367 4202
Fax: +254-20-367 4341
Website: www.au-ibar.org

Aligui Djiteye
PATTEC Coordinator Mali
P.O. Box 9125
Sotuba, Bamako
Tel: +233 22 1985
E-Mail: addjiteye01@yahoo.com

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

www.ilri.org
PO Box 30709 Nairobi 00100, Kenya