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CSIRLT

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Thirty Fourth Meeting
34ème REUNION

LIVINGSTONE, ZAMBIA
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(ISCTRC)

Conseil Scientifique International pour la Recherche et la Lutte contre les Trypanosomiases

(CSIRLT)

THIRTY FOURTH MEETING

34ème REUNION

LIVINGSTONE, ZAMBIA

2017

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RECOMMENDATIONS OF THE 34TH CONFERENCE OF THE INTERNATIONAL SCIENTIFIC COUNCIL FOR TRYPANOSOMIASIS RESEARCH AND CONTROL (ISCTRC) AND THE 16TH PATTEC COORDINATORS MEETING HELD IN LIVINGSTONE, ZAMBIA, FROM 11TH TO 15TH SEPTEMBER 2017

The Meeting acknowledged the high quality presentations made under the various thematic areas and the resultant discussions. The following recommendations were therefore, made:

1. That the African Union was requested to sensitise the national government officials through advocacy, with a view to influence policies on tsetse and trypanosomiasis (T&T), focussing on the allocation of resources and sustainability of control programs. The meeting therefore agreed that the recommendations of the 34th ISCTRC conference be brought to the attention of the Specialised Technical Committee (STC) of Ministers in charge of Agriculture, Rural Development, Water and Environment, during their meeting to be held on October 5 and 6, 2017 organized by African Union at Addis Ababa, Ethiopia.

2. The meeting noted with concern the lack of guidelines for use by the PATTEC country programmes. It was therefore recommended that the African Union takes the lead and collaborate with mandated international organisations in the development of these guidelines for the declaration of tsetse free areas.

3. It was also noted with concern that many countries have not integrated T&T strategies into their National Agricultural Investment Plans as a priority for the mobilization of national and regional resources. Countries need to be reminded about the Head of States' and Government decision made in Lomé-Togo in the year 2000 to eradicate tsetse flies and eliminate trypanosomiasis from Africa. This should assist in prioritization by national governments in allocation of resources for T&T programs.

4. The meeting took note of the absence of regional reports and recognized the need to adopt a regional approach in the development of projects and in the search for funding. In this regard, the support of the Regional Economic Organizations will be especially sought. The AU-PATTEC Coordination Office will then be able to provide technical support to countries affected by the T&T and play the role of facilitator in resource mobilisation.

5. Noting with concern the increasing fragmented approach being pursued by partners in their efforts to contribute to the fight against T&T, it was recommended that ISCTRC and the AU-PATTEC Coordination Office should develop multi-stakeholder partnership frameworks designed as a basis for partners' contributions to the fight against T&T.

6. Noting with concern the apparent disconnect between T&T research and field operations and the increasing trends where some researchers and research institutions are doubling as field implementers, it was recommended that the ISCTRC strengthens its coordination role to enhance policy dialogue in the translation of T&T research outputs into field application.

7. Progressive pathways and the related roadmaps are being successfully used for the control of different diseases (i.e. FMD, PPR, brucellosis and rabies). The approach has been recently adapted to AAT by FAO, in collaboration with AU-PATTEC, IAEA and CIRAD. ISCTRC welcomes the development of this new strategic tool in support of the PATTEC initiative, and recommends that:

    a. Support be given for its further refinement so as to pave the way to its subsequent implementation in AAT-affected countries and at the international level. The meeting also recommended that the application of PCP explored for non-tsetse transmitted trypanosomiasis by working closely with the OIE.

    b. Stakeholders involved in AAT PCP to engage OIE delegates in the process of placing the PCP initiative on OIE's agenda through formal consultations with OIE to ensure the PCP compliance with the OIE Terrestrial Animal Health Code regarding standards for each of the steps.

8. The meeting observed with great concern the widespread occurrence of counterfeit drugs and/or drug misuse and the resultant phenomenon of treatment failure. The general consensus was that all relevant stakeholders should work more closely with the relevant government arms to address the crisis using new approaches including establishment of testing labs.

9. It was noted also with concern that PATTEC Country reports lacked information and detail on non-tsetse transmitted trypanosomiasis, and recommended that efforts be made to give adequate prominence to this very important area.

10. On the issue of HAT research, control/elimination as a public health concern by 2020 and noting the continued and remarkable progress made. The meeting recommended:

    a. That control strategies should be adapted accordingly to the subsequent changes in epidemiological status, as well as to the new tools becoming available;

    b. That the ownership of countries of the elimination goal should be reinforced to ensure political sustainability of the process while progressive integration of control and surveillance activities in the routine health system should also be recommended to ensure the technical sustainability;

    c. That in order to improve surveillance of the disease, the use of existing tools should be optimized, and quality be regularly monitored. It must be stressed that parasitological confirmation of cases remains essential. New diagnostic tools and algorithms should be independently evaluated. Initiatives to improve funding and access to screening and diagnostic tools were encouraged;

    d. That despite the relatively lower burden of rhodesiense Human African Trypanosomiasis (HAT), it is important to consider its situation and its particularities in order to ensure it is not left out:

        - A multisectoral approach (One Health) is essential to address this disease;
        - The increased use of rapid diagnostic tests (RDTs) for malaria has reduced the use of blood smear microscopy for this purpose, thus incidentally diminishing the possibility of diagnosing rhodesiense HAT via microscopy in the same patient. The use of blood smear microscopy in rhodesiense HAT endemic areas should be encouraged;
        - Considering the significant adverse events related to current therapeutic tools for rhodesiense HAT, the ISCTRC encourages partners to invest all possible efforts to extending the clinical trials of fexinidazole as a treatment for rhodesiense HAT;

    e. That taking into account the importance of the Atlas of HAT in mapping the disease and supporting the planning of activities for HAT elimination, the transfer of capacity for the use of this tool at national level in endemic countries is highly encouraged;

11. The meeting appreciated efforts made to generate new knowledge in the areas of parasite and vector genetics/genomics/proteomics and chemical ecology e.g tsetse population genetics, vector and disease predictive modeling, tsetse attractants/repellants and transmission blocking vaccines

using metacyclic antigens. The meeting recommended translation and sharing of this knowledge with national control programmes to enhance control efforts and allocation of funds.

12. On the issue of vector research, sustainable/elimination the meeting made the following recommendations:

    a. That there have been recent developments and access to new tools for T&T control and that these need to be optimized for different applications by national control programmes;

    b. That tsetse control interventions should take into consideration spatial distribution and trypanosome infection in order to maximise cost-benefit ratios in the control of AAT;

    c. That tsetse control interventions should take into consideration sustainability mechanisms to avoid re-infestation of controlled areas;

    d. The new tools presented should be taken into consideration for T&T control and to update tsetse distribution according to climate and land use changes.

    e. Considering the link between tsetse distribution and climate change and T&T control, institutions with focus on climate change issues should be approached for funding;

    f. Non-tsetse transmitted trypanosomiasis continues to be an important area and it is recommended that efforts should be enhanced in the development of new olfaction and visual baits for the control of the vectors to maximise control of Trypanosoma evansi infections;

13. It was recognized that the training and mentoring of young scientists was crucial in addressing the growing manpower demands of tsetse and trypanosomiasis research/control. In this regard the meeting appreciated the efforts of organisations that have supported capacity building and appealed to others to contribute.

RECOMMANDATIONS DE LA 34ÈME CONFÉRENCE DU CONSEIL SCIENTIFIQUE INTERNATIONAL POUR LA RECHERCHE ET LA LUTTE CONTRE LES TRYPANOSOMOSES (CSIRLT) ET DE LA 16ÈME RÉUNION DES COORDONNATEURS PATTEC TENUES À LIVINGSTONE EN ZAMBIE DU 11 AU 15 SEPTEMBRE 2017

Les participants à la réunion se sont félicités de l'excellente qualité des exposés présentés dans le cadre des différents domaines thématiques et des débats correspondants. Ils ont ensuite formulé les recommandations ci-après:

1. Qu'il soit demandé à l'Union africaine de sensibiliser les responsables des gouvernements nationaux par voie de plaidoyer, en vue d'influencer les politiques sur le contrôle des mouches tsé-tsé et des trypanosomoses (T & T), en mettant l'accent sur l'allocation des ressources et la durabilité des programmes de contrôle. Les participants à la réunion ont donc convenu que les recommandations de la 34ème Conférence du CSIRLT soient portées à l'attention du Comité technique spécialisé (CTS) des ministres en charge de l'Agriculture, du Développement rural, de l'Eau et de l'Environnement lors de leur réunion organisée par l'Union africaine, qui se tiendra à Addis-Abeba en Éthiopie les 5 et 6 octobre 2017.

2. Les participants ont noté avec préoccupation le manque de lignes directrices dont pourraient se servir les programmes PATTEC nationaux. Ils ont donc recommandé que l'Union africaine joue le rôle de premier plan et collabore avec les organisations internationales mandatées dans l'élaboration de ces lignes directrices pour la déclaration de zones indemnes de mouches tsé-tsé.

3. Ils ont également noté avec préoccupation que de nombreux pays n'ont pas intégré les stratégies de lutte contre les T & T dans leurs plans de développement nationaux en tant que priorité pour la mobilisation des ressources nationales et régionales. Il faudrait rappeler aux pays la décision prise par les chefs d'État et de gouvernement à Lomé (Togo) en 2000, d'éradiquer les mouches tsé-tsé et d'éliminer les trypanosomoses en Afrique. Cette décision devrait aider les gouvernements nationaux à définir les priorités dans l'allocation de ressources en faveur des programmes de contrôle des T & T.

4. Les participants à la conférence ont pris acte de l'absence de rapports régionaux, et ont reconnu la nécessité d'adopter une approche régionale pour l'élaboration de projets et la recherche de financements. À cet égard, le soutien des organisations économiques régionales sera particulièrement

sollicité. Le Bureau de coordination de l'UA-PATTEC pourra alors apporter un appui technique aux pays affectés par les T & T et jouer le rôle de facilitateur dans la mobilisation de ressources.

5. Notant avec préoccupation l'approche de plus en plus fragmentée mise en oeuvre par les partenaires dans les efforts qu'ils déploient pour contribuer à la lutte contre les T & T, les participants ont recommandé au CSIRLT et au Bureau de coordination de l'UA-PATTEC d'élaborer des cadres de partenariat pluripartites, conçus comme base des contributions des partenaires au contrôle des T & T.

6. Préoccupés par le cloisonnement apparent entre les recherches sur les T & T et les opérations sur le terrain, et par les tendances croissantes selon lesquelles certains chercheurs et instituts de recherche assument également le rôle d'exécutants sur le terrain en sus de leurs activités de recherche, les participants ont recommandé au CSIRLT de renforcer son rôle de coordination afin d'améliorer le dialogue politique dans l'application des résultats des recherches sur les T&T sur le terrain.

7. Des approches progressives et des feuilles de route connexes sont actuellement utilisées avec succès dans le contrôle de différentes maladies (i.e. la fièvre aphteuse, la PPR, la brucellose et la rage). La FAO a récemment adapté cette approche à la TAA, en collaboration avec l'UA-PATTEC, l'AIEA et CIRAD. Le CSIRLT se félicite de la mise au point de ce nouvel outil stratégique en appui à l'initiative PATTEC et recommande que :

   a. un soutien soit accordé pour le perfectionnement de cette approche, de manière à ouvrir la voie à sa mise en œuvre ultérieure dans les pays affectés par la TAA et au niveau international. Les participants à la réunion ont également recommandé que l'application de l'approche PCP soit explorée pour la trypanosomiase non transmise par les mouches tsé-tsé, à travers une collaboration étroite avec l'OIE.

   b. es parties prenantes impliquées dans l'approche PCP pour la TAA associent les délégués de l'OIE au processus d'inscription de l'initiative PCP sur le programme de l'OIE à travers des consultations formelles avec l'OIE afin de s'assurer que l'initiative PCP est conforme au Code sanitaire de l'OIE pour les animaux terrestres en ce qui concerne les normes applicables à chacune des étapes.

8. Les participants ont noté avec une grande inquiétude la présence généralisée de médicaments contrefaits et / ou l'utilisation abusive de médicaments et l'échec thérapeutique qui en résulte. Le consensus général qui s'est dégagé était que toutes les parties intéressées doivent travailler

étroitement avec les services gouvernementaux concernés pour résoudre cette crise en utilisant de nouvelles approches, notamment la mise en place de laboratoires de contrôle à cet effet.

9. Ils ont également noté avec préoccupation que les rapports PATTEC nationaux ne contenaient pas suffisamment d'informations et de détails sur la trypanosomiase non transmise par la mouche tsé-tsé, et ont recommandé que des efforts soient déployés pour donner une plus grande place à ce domaine très important.

10. En ce qui concerne la question de la recherche, du contrôle / de l'élimination de la THA en tant que problème de santé publique d'ici 2020, et prenant note des progrès continus et remarquables accomplis, les participants ont recommandé :

    a. que les stratégies de contrôle soient adaptées en fonction des changements ultérieurs du statut épidémiologique ainsi que des nouveaux outils disponibles ;

    b. que l'appropriation, par les pays, de l'objectif d'élimination soit renforcée afin d'assurer la durabilité politique du processus, et que l'intégration progressive des activités de contrôle et de surveillance dans le système de santé courant soit également recommandée pour assurer la durabilité technique ;

    c. que dans la perspective de l'amélioration de la surveillance de la maladie, l'utilisation des outils existants soit optimisée et que leur qualité soit régulièrement contrôlée. Il faut souligner que la confirmation parasitologique des cas reste essentielle. Les nouveaux outils et algorithmes de diagnostic doivent être évalués de manière indépendante. Les initiatives visant à améliorer le financement et l'accès aux outils de dépistage et de diagnostic ont été encouragées ;

    d. qu'en dépit de la charge relativement faible de la trypanosomiase humaine africaine (THA) à rhodesiense, il est important de prendre en compte sa situation et ses particularités afin de s'assurer qu'elle est également abordée :

        - Une approche multisectorielle (une seule santé) est essentielle pour lutter contre cette maladie ;
        - L'utilisation accrue des tests de diagnostic rapide (TDR) pour le paludisme a réduit l'utilisation de la microscopie des frottis sanguins à cette fin, réduisant incidemment la possibilité de diagnostiquer la THA à rhodesiense par microscopie chez le même patient. L'utilisation de la microscopie des frottis sanguins dans les zones endémiques pour la THA à rhodesiense doit être

encouragée ;

- Compte tenu des effets indésirables importants liés aux outils thérapeutiques actuels pour la THA à rhodesiense, le CSIRLT encourage les partenaires à investir tous les efforts possibles dans l'extension des essais cliniques du fexinidazole comme traitement de la THA à rhodesiense ;

e. Que compte tenu de l'importance de l'Atlas de la THA dans la cartographie de la maladie et l'appui à la planification des activités d'élimination de cette maladie, le transfert de capacités pour l'utilisation de cet outil au niveau national dans les pays où elle est endémique est fortement encouragé.

11. Les participants à la réunion se sont félicités des efforts déployés dans le but de générer de nouvelles connaissances dans les domaines de la génétique / la génomique / la protéomique et l'écologie chimique du parasite et du vecteur, par exemple la génétique des populations de glossines, la modélisation prédictive du vecteur et de la maladie, les attractifs / les répulsifs de mouches tsé-tsé et les vaccins de blocage de transmission utilisant des antigènes métacycliques. Les participants ont recommandé l'application et le partage de ces connaissances au niveau des programmes nationaux de contrôle afin d'améliorer les efforts de lutte contre la maladie et l'allocation des fonds.

12. En ce qui concerne la question de la recherche, du contrôle / de l'éradication du vecteur, les participants ont formulé les recommandations suivantes :

a. Que les découvertes récentes et l'accès aux nouveaux outils de contrôle des T & T soient optimisés pour différentes applications par les programmes de contrôle nationaux ;

b. Que les interventions de lutte contre la mouche tsé-tsé prennent en considération la distribution spatiale et l'infection par les trypanosomes, afin de maximiser les rapports coût-bénéfice dans le contrôle de la TAA ;

c. Que les interventions de contrôle des mouches tsé-tsé prennent en considération les mécanismes de durabilité afin d'éviter la ré-infestation des zones assainies ;

d. Les nouveaux outils présentés doivent être pris en compte dans le contrôle des T & T et la mise à jour de la distribution des mouches tsé-tsé en fonction des changements du climat et de l'utilisation des terres ;

e. Compte tenu du lien entre la distribution des mouches tsé-tsé et les changements climatiques et le contrôle des T &T, les institutions dont

les travaux sont axés sur les changements climatiques devraient être sollicitées pour contribuer à l'effort de financement ;

f. La trypanosomiase non transmise par les mouches tsé-tsé reste un domaine important ; il est donc recommandé d'accroître les efforts de mise au point de nouveaux appâts olfactifs et visuels pour le contrôle des vecteurs afin de maximiser le contrôle des infections à Trypanosoma evansi.

13. Les participants ont reconnu que la formation et le mentorat de jeunes scientifiques jouent un rôle crucial dans la mesure où ils permettent de répondre aux demandes croissantes de main-d'œuvre dans les domaines de la recherche et du contrôle des mouches tsé-tsé et des trypanosomoses. À cet égard, les participants ont salué les efforts des organisations qui ont soutenu le renforcement des capacités dans ce cadre, et ont demandé aux autres entités de contribuer à cet effort.

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REPORT OF THE ISCTRC SECRETARY ON THE JOINT 34TH ISCTRC GENERAL CONFERENCE AND THE 16TH PATTEC NATIONAL COORDINATORS MEETING

Opening ceremony

The 34th ISCTRC Conference and the 16th PATTEC Coordinators' meeting was held at the AVANI Victoria Falls Resort in Livingstone, Zambia between the 11th and 15th of September 2017. The Conference theme was, 'Capitalizing on the progress made against human and animal trypanosomiases– the way forward in partnership with all stakeholders'.

The conference was officially opened by the Minister for Fisheries and Livestock, Hon. Michael Katambo on behalf of His Excellency Mr. Edgar Changwa Lungu, President of the Republic of Zambia. The keynote address was presented by the Director of Rural Economy and Agriculture, African Union Commission, Dr Godfrey Bahiigwa on behalf of the Commissioner, H.E. Mrs. Josefa Sacko. In this key note address, it was acknowledged that a lot of work has been done during the past 68 years of combating tsetse and trypanosomiasis (T&T) and it is now time to review the substantial progress made in terms of institutional arrangements, research, available technologies, approaches, partnerships, investments and lessons learned in order to bring the tsetse fly vector and trypanosomiasis under control in Africa.

The Director of AU-IBAR, Prof Ahmed Elsawalhy elaborated on the objectives of the 34th ISCTRC Conference and the 16th PATTEC Coordinators Meeting which are; to review the status of the PATTEC T&T intervention activities in the different countries; to review T&T control technologies, strategies and policy options; to dentify gaps in research and control and to make recommendations for T&T research and control for the next two years. He thanked His Excellency Mr. Edgar Changwa Lungu for the commitment of his Government in the fight against human and animal trypanosomiasis.

The opening ceremony was also graced by the Honourable Minister for Southern Province, Hon. Dr. Edify Hamukale; the Deputy Mayor representing His Worship the Mayor of Livingstone, Councilor Eugene Mapuwo; Their Royal Highnesses, the Traditional Leaders; the Permanent Secretary for Fisheries and Livestock, Dr. David Shamulenge and the Principal Secretary, State Department of Livestock in the Republic of Kenya, Dr. Andrew Tuimur. In his opening remarks, the Minister highlighted the impact of tsetse and trypanosomiasis on rural development and human welfare on the African continent and called for concerted efforts to ensure total removal of the tsetse fly from the continent.

Conference participants and presentations

The conference was attended by 301 participants from 34 African countries and beyond and by the representatives of Regional and International organizations. The presentations focused on the following thematic areas: The Pan African Tsetse and Trypanosomiasis Campaign (PATTEC); Human African Trypanosomiasis (HAT); Animal African Trypanosomiasis (AAT); Tsetse Biology and Control and Socio-Economics, Environment and Land Use. Keynote addresses were delivered under each of the thematic areas; and symposia were held with a focus on emerging themes such as tsetse and parasite genetics/genomics/proteomics.

During this meeting one hundred and fifteen (115) scientific presentations were made, ninety (90) of which were presented orally while twenty five (25) were presented as posters. Twenty seven (27) African countries presented their reports on progress of tsetse and trypanosomiasis activities since the last ISCTRC Conference held in Ndjamena Chad in the year 2015.

The inclusion of T&T control and elimination strategies and programmes into national development plans was highlighted as critical for the resource mobilization and sustainability of the fight against T&T.

The Conference appreciated the efforts made by National, Regional and International Organizations in ensuring access by the disease endemic countries to appropriate tools for tsetse and trypanosomiasis interventions. The elimination of HAT and the progressive control of AAT appear today as achievable and necessary goals, and they should be supported by all stakeholders in a coordinated manner.

It was recognized that the training and mentoring of young scientists was crucial in addressing the growing human resources demands of tsetse and trypanosomiasis research/control. In this regard the meeting appreciated the efforts of organisations that have supported capacity building and appealed to others to contribute to this noble effort.

The meeting observed with great concern the widespread occurrence of counterfeit drugs and/or drug misuse and the resultant phenomenon of treatment failure. The general consensus was that all relevant stakeholders should work more closely with the relevant government arms to address the crisis in the shortest possible time.

The meeting appreciated the efforts made by scientists to generate new knowledge and tools that are appropriate in the planning of control/elimination programmes and advocated for their validation and adoption.

Historical perspectives and the mandate and functions of the AU-IBAR/ ISCTRC were presented and discussed. The meeting recommended the strengthening of the council to enable it respond to emerging challenges and new technological advancements.

The status of T&T elimination in Africa with respect to gains registered, challenges, lessons learned, best practice and future perspectives was presented and discussed.

The meeting made a number of recommendations that require implementation. To this end, the conference deliberations will be brought to the attention of the meeting of Specialised Technical Committee (STC) of Ministers in charge of Agriculture, Rural Development, Water and Environment on October 5 and 6 2017 organized by the African Union Commission in Addis Ababa, Ethiopia.

Participants expressed their gratitude to the Government and people of Zambia for accepting to host the meeting and for the warm hospitality that they received.

Distribution of the proceedings of the 33rd Conference

During the Conference proceedings of the 33rd ISCTRC Conference were distributed to the participants in soft copies.

41st ISCTRC Executive Committee meeting

The 41st ISCTRC Executive Committee meeting was held on 10th and 15th September 2017 at the Avani Victoria Falls Resort. In attendance were the regional representatives from the 4 regions of Africa infested by tsetse flies namely, Southern, Central, Eastern and West Africa. Other participants were the outgoing chairman of ISCTRC, the incoming chairman of ISCTRC, the National Organising Committee (NOC), AU-IBAR, AU-PATTEC, Food and Agriculture Organisation of the United Nations (FAO), International Livestock Research Institute (ILRI). International Atomic Energy Agency (IAEA) and World Health Organisation.

The meeting received the ISCTRC Secretariat report and reviewed preparedness for the 34th ISCTRC Conference.

The 41st ISCTRC Executive committee discussed and agreed on the following:

- That the last few ISCTRC Conferences had been held in the following venues; 2007 in Luanda, Angola; 2009 in Kampala, Uganda; 2011 in Bamako Mali; 2013 in Khartoum, Sudan and in 2015 in Ndjamena, Chad. Based on the criteria for selecting regions and countries to host the Conference, the meeting observed that the next Conference should be held in West Africa;
- That the 2006 ISCTRC Constitution be reviewed and revised to be in line with the current institutional and operational environment and that it should be endorsed and ratified during the 35th ISCTRC Conference;
- Partners to consider supporting pre-conference training to build capacity of young scientists and disease control workers;
- That Scaling up of advocacy for T&T be undertaken at all levels and that;
- That RECS, Universities, and Northern Region be represented in the ISCTRC Executive Committee.

Members of the Executive Committee 2017-2019

The following were the Members of the ISCTRC Executive Committee for the period 2017-2019:

Southern Africa:

- Mr. Patrick Kngori, Botswana,
- Mr. Williams Shereni, Zimbabwe

Central Africa:

- Ndoutamia G. Anaclet, Central Africa Republic;
- Dr.Lisette Kohagne, Cameroon

Eastern Africa:

- Dr. Pamela Olet, Kenya;
- Dr. Charles Wamboga, Uganda

West Africa:

- Prof Mamman Mohamed, Nigeria;
- Dr. Baba Sall, Senegal

Chairman and Vice-Chair

- Prof Namangala(Vice Chair &Chair-elect)
- Prof Prof. Idriss Al – Faroukh, Chad (Chairman)

Ex-officio members of the Executive Committee:

- AU-IBAR, AU-PATTEC, FAO, IAEA, PAAT, WHO, ICIPE, ILRI, CIRDES

Dr. James K. Wabacha

ISCTRC Secretary, AU-IBAR

Nairobi, Kenya

September, 2017

RAPPORT DU SECRÉTAIRE DU CSIRLT SUR LA 34ÈME CONFERENCE GÉNÉRALE DU CSIRLT ET LA 16ÈME RÉUNION DES COORDONNATEURS NATIONAUX DE L'INITIATIVE PATTEC

Cérémonie d'ouverture

La 34ème Conférence du CSIRLT et la 16ème Réunion des coordonnateurs de l'initiative PATTEC se sont tenues à l'AVANI Victoria Falls Resort à Livingstone en Zambie, du 11 au 15 septembre 2017. La conférence était placée sous le thème « Exploiter les progrès accomplis dans la lutte contre les trypanosomiases humaine et animale en partenariat avec toutes les parties prenantes – perspectives d'avenir ».

La conférence a été officiellement ouverte par le ministre de la Pêche et de l'Élevage, l'Honorable Michael Katambo, au nom du Président de la République de Zambie, Son Excellence Monsieur Edgar Changwa Lungu. Le discours principal a été présenté par le Directeur du Département de l'Économie rurale et de l'Agriculture de la Commission de l'Union africaine, Dr Godfrey Bahiigwa, au nom de la Commissaire à l'Économie rurale et à l'Agriculture, Son Excellence Mme Josefa Sacko. Dans son discours, Dr. Bahiigwa a salué les efforts considérables déployés au cours des 68 dernières années dans la lutte contre la mouche tsé-tsé et la trypanosomiase (T&T), et a indiqué que le moment était venu d'examiner les progrès importants réalisés au regard des dispositions institutionnelles, recherches, technologies disponibles, approches, partenariats, investissements et enseignements retenus afin de maîtriser la mouche tsé-tsé et la trypanosomiase en Afrique.

Le Directeur de l'UA-BIRA, le Professeur Ahmed Elsawalhy, a exposé en détail les objectifs de la 34ème Conférence du CSIRLT et de la 16ème Réunion des coordonnateurs de l'initiative PATTEC. Ces objectifs consistent à : examiner l'état d'avancement des activités d'intervention menées par le programme PATTEC dans la lutte contre la mouche tsé-tsé et la trypanosomiase (T&T) dans les différents pays ; passer en revue les technologies, stratégies et options politiques pour le contrôle des T & T ; identifier les lacunes au niveau de la recherche et du contrôle des T & T et formuler des recommandations dans ce domaine pour les deux prochaines années. Il a remercié Son Excellence Monsieur Edgar Changwa Lungu pour l'engagement de son Gouvernement dans la lutte contre les trypanosomiases humaine et animale.

Plusieurs personnalités ont honoré de leur présence la cérémonie d'ouverture de la conférence, à savoir le Ministre de la Province du Sud, Honorable Dr. Edify Hamukale ; le Maire adjoint représentant Son Honneur le Maire

de Livingstone, le conseiller Eugene Mapuwo ; Leurs Altesses Royales, les chefs traditionnels ; le Secrétaire permanent à la Pêche et à l'Élevage, Monsieur David Shamulenge, et le Secrétaire principal au Département d'État en charge de l'élevage en République du Kenya, Andrew Tuimur. Dans son allocution d'ouverture, le Ministre zambien a souligné l'impact de la mouche tsé-tsé et de la trypanosomiase sur le développement rural et le bien-être des habitants d'Afrique, et a lancé un appel en faveur d'efforts concertés en vue de l'élimination totale de la mouche tsé-tsé du continent.

Participants et exposés présentés à la Conférence

Ont participé à cette conférence 301 participants venus de 34 pays africains et de l'extérieur du continent, ainsi que des représentants d'organisations régionales et internationales. Les exposés se sont focalisées sur les domaines thématiques ci-après : Campagne panafricaine de lutte contre la mouche tsé-tsé et la trypanosomiase (PATTEC) ; Trypanosomiase humaine africaine (THA) ; Trypanosomiase animale africaine (TAA) ; Biologie et contrôle des glossines ; et Socioéconomie, environnement et utilisation des terres. Des discours - thèmes ont été prononcés pour les différents domaines thématiques ; et des colloques ont été organisés sur des thèmes émergents tels que la génétique / génomique / protéomique des mouches tsé-tsé et des parasites.

Au cours de cette réunion, cent quinze (115) exposés scientifiques ont été faits, dont quatre-vingt-dix (90) présentés oralement et vingt-cinq (25) sous forme de posters. Vingt-sept (27) pays africains ont présenté leurs rapports nationaux sur l'état d'avancement des activités de lutte contre les mouches tsé-tsé et les trypanosomiases depuis la dernière conférence du CSIRLT tenue à Ndjamena au Tchad en 2015.

L'inclusion de stratégies et de programmes de contrôle et d'élimination des mouches tsé-tsé et des trypanosomiases (T & T) dans les plans de développement nationaux a été soulignée comme étant essentielle à la mobilisation de ressources et à la durabilité de la lutte contre les T & T.

La Conférence s'est félicitée des efforts déployés par les organisations nationales, régionales et internationales pour assurer aux pays d'endémie de la maladie un accès aux outils appropriés aux interventions de lutte contre les glossines et les trypanosomiases. L'élimination de la THA et le contrôle progressif de la TAA apparaissent aujourd'hui comme des objectifs réalisables et nécessaires qui devraient être soutenus par toutes les parties prenantes de manière concertée.

Les participants ont reconnu que la formation et l'encadrement de jeunes scientifiques sont essentiels dans la mesure où ils permettent de répondre aux exigences croissantes en ressources humaines en matière de recherche / contrôle des glossines et des trypanosomiases. À cet égard, ils ont salué les efforts des organisations qui ont soutenu le renforcement des capacités, et ont demandé aux autres de contribuer également à ce noble effort.

Les participants à la réunion ont noté avec une grande inquiétude la présence considérable de médicaments contrefaits et / ou l'abus de médicaments et le phénomène d'échec thérapeutique associé. Le consensus général était que toutes les parties prenantes concernées devraient travailler plus étroitement avec les instances gouvernementales concernées pour remédier à cette crise dans les plus brefs délais.

Les participants ont salué les efforts déployés par les scientifiques pour produire de nouvelles connaissances et de nouveaux outils appropriés pour la planification des programmes de contrôle / d'élimination des T&T et ont préconisé leur validation et adoption.

Les perspectives historiques ainsi que le mandat et les fonctions de l'UA-BIRA / CSIRLT ont été présentés et discutés. Les participants à la réunion ont recommandé le renforcement des capacités du Conseil pour l'habiliter à répondre aux défis émergents et aux nouveaux progrès technologiques.

La situation de l'élimination des T & T en Afrique en termes de gains enregistrés, de défis, de leçons retenues, de bonnes pratiques et de perspectives futures a été présentée et fait l'objet de discussions.

Les participants à la réunion ont formulé un certain nombre de recommandations dont la mise en application s'impose. À cette fin, les délibérations de la conférence seront portées à l'attention des participants à la réunion du Comité technique spécialisé (CTS) des ministres en charge de l'Agriculture, du Développement rural, de l'Eau et de l'Environnement, qui aura lieu les 5 et 6 octobre 2017 à Addis-Abeba en Éthiopie au siège de la Commission de l'Union africaine.

Les participants ont remercié le Gouvernement et le Peuple de Zambie pour l'accueil de la réunion et la généreuse hospitalité qui leur a été réservée.

Distribution des actes de la 33ème Conférence

Au cours de cette rencontre, les travaux de la Trente-troisième Conférence du CSIRLT ont été distribués aux participants sous format électronique.

Quarante-et-unième (41ème) session du Comité exécutif du CSIRLT

La 41ème réunion du Comité exécutif du CSIRLT s'est tenue du 10 au 15 septembre 2017 à l'Avani Victoria Falls Resort. Y ont participé les représentants régionaux des 4 régions d'Afrique infestées par la mouche tsé-tsé, à savoir : l'Afrique australe, l'Afrique centrale, l'Afrique orientale et l'Afrique de l'Ouest. Les autres participants étaient le président sortant du CSIRLT, le nouveau président du CSIRLT, le Comité national d'organisation (CNO), l'UA-BIRA, l'UA-PATTEC, l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO), l'Institut international de recherche sur l'élevage (ILRI), l'Agence internationale de l'énergie atomique (AIEA) et l'Organisation mondiale de la santé.

Les participants à la réunion ont reçu le rapport du Secrétariat du CSIRLT et ont abordé la préparation à la 34ème Conférence du CSIRLT.

Les participants à la 41ème Réunion du Comité exécutif du CSIRLT ont débattu et convenu de ce qui suit :

- que les dernières conférences du CSIRLT se sont tenues aux dates et lieux suivants : 2007 à Luanda en Angola ; 2009 à Kampala en Ouganda ; 2011 à Bamako au Mali ; 2013 à Khartoum au Soudan ; 2015 à Ndjamena au Tchad. Sur la base des critères de sélection des régions et des pays pour l'accueil de la conférence, les participants ont convenu que la prochaine conférence devrait se tenir en Afrique de l'Ouest ;
- que les statuts du CSIRLT de 2006 soient réexaminés et révisés pour être alignés sur l'environnement institutionnel et opérationnel actuel et qu'ils soient approuvés et ratifiés lors de la 35ème Conférence du CSIRLT ;
- que les partenaires envisagent de soutenir une formation préalable à la conférence afin de renforcer les capacités des jeunes scientifiques et des agents de contrôle de la maladie ;
- que soit entrepris à tous les niveaux un renforcement du plaidoyer en faveur de la lutte contre les T & T ; et
- que les CER, les universités et la Région Nord soient représentées au sein du Comité exécutif du CSIRLT.

Membres du Comité exécutif pour la période 2017-2019

Les noms des membres du Comité exécutif du CSIRLT pour la période 2017-2019 sont repris ci-dessous :

Afrique australe :

- M. Patrick Kngori (Botswana)
- M. Williams Shereni (Zimbabwe)

Afrique centrale :

- Ndoutamia G. Anaclet (République Centrafricaine)
- Dr Lisette Kohagne (Cameroun)

Afrique orientale :

- Dr Pamela Olet (Kenya)
- Dr Charles Wamboga (Ouganda)

Afrique de l'Ouest :

- Pr Mamman Mohamed (Nigéria)
- Dr Baba Sall (Sénégal)

Président et Vice-Président

- Pr Namangala (Vice-Président & Président élu)
- Pr Idriss Al – Faroukh [(Tchad) (Président)]

Membres d'office du Comité exécutif :

- UA-BIRA, UA-PATTEC, FAO, AIEA, PLTA, OMS, ICIPE, ILRI, CIRDES

Dr James K. Wabacha

Secrétaire du CSIRLT, UA-BIRA

Nairobi, Kenya

Septembre 2017

SPEECHES/DISCOURS

KEY NOTE ADDRESS BY H.E. MRS. JOSEFA SACKO COMMISSIONER FOR RURAL ECONOMY AND AGRICULTURE AFRICAN UNION COMMISSION

- Your Excellency, the Vice President of the Republic of Zambia, Madam Inonge Wina, MP,
- The Minister for Fisheries and Livestock, Hon. Michael Katambo, MP
- Honourable Minister for Southern Province, Hon. Dr. Edify Hamukale, MP
- Your Worship the Mayor of Livingstone, Councillor Eugene Mapuwo,
- Your Royal Highnesses, Traditional Leaders present
- The Permanent Secretary for Fisheries and Livestock, Dr. David Shamulenge,
- The Principal Secretary for Agriculture and Livestock of the Republic of Kenya, Dr. Andrew Tuimur
- Members of the Diplomatic Corps
- The out-going Chairman of the ISCTRC Prof Rahman
- The incoming Chairman of ISCTRC Prof. Namangala
- Executive Committee Members of the ISCTRC
- Representatives of International Organizations
- Distinguished Delegates and Participants
- Eminent Scientists
- The National Organizing Committee Members
- Distinguished Guests
- Ladies and Gentlemen

Your Excellency we welcome you to our conference and are gratified by your presence on this occasion. Through Your Excellency, I would like first to express my appreciation to the Government and the People of the Republic of Zambia for collaborating with the African Union Commission in organising and convening the 34th International Scientific Council for Trypanosomiasis Research and Control (ISCTRC) General Conference and the 16th PATTEC National Coordinators meeting, and for the warm welcome and hospitality accorded to all of us. Our gratitude also goes to our cooperating partners.

I also welcome all delegates representing our Member States, international organizations, research institutions and all participants to this important conference.

The theme of this conference 'Capitalizing on the progress made against human and animal trypanosomiases– the way forward in partnership with all stakeholders' comes at an appropriate time as the International Scientific Council for Trypanosomiasis Research and Control (ISCTRC) is 68 years old. After 68 years of combatting tsetse fly and trypanosomiasis it is time to come together to review the substantial progress made in term of institutional arrangements, research, available technologies, approaches, partnerships, investments and lessons learned in order to bring tsetse fly and trypanosomiasis under control in Africa.

Tsetse and trypanosomiasis continue to be a huge challenge in rural areas of Africa. The tsetse belt occupies approximately 10 million square kilometres spanning over 38 African countries. This area is one third of the African Continent! In this belt, 50 million cattle live within or at the margin of tsetse infested areas and are at risk of African Trypanosomiasis. The loss due to Animal African Trypanosomiasis is substantial and it is estimated at US$ 5 billion a year. This hampers the development of the livestock sector on the continent and compromises the achievement of the objectives of the Malabo Declaration on Agricultural transformation and indeed Africa's Agenda 2063 towards the Africa we want. Specifically the scourge of tsetse and trypanosomiasis, if not addressed, will hinder the successful implementation of the Livestock Development strategy for Africa (LiDeSA)

Human sleeping sickness continues to pose a public health risk in many areas of rural Africa. It is estimated that the population at risk is about 60 million people with about 2,000 cases of human sleeping sickness being reported annually.

Your Excellency, Vice President,

Honourable Minister,

Distinguished Delegates and Participants

The desire to coordinate and harmonise efforts on tsetse and trypanosomiasis research and control, given the transboundary nature of trypanosomiasis, and the need for efficiency and effectiveness in the delivery of tsetse and trypanosomiasis interventions led to the establishment of International

Scientific Council for Trypanosomiasis Research and Control (ISCTRC) in 1949. The Secretariat of the Council is at the African Union Inter-African Bureau for Animal resources (AU-IBAR), in Nairobi Kenya.

The desire for collective efforts in this area was further demonstrated by Heads of State and Government in the year 2000, when, noting the serious threat that trypanosomiasis epidemics of the 1990's were posing to both human and animal health and compromising the rural development, endorsed the establishment of the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC). This is a continent wide Campaign aimed at joint efforts and collaborative country-wide activities to control and eradicate tsetse and trypanosomiasis in the 38 infested African countries.

Other institutions that are involved or have been involved in tsetse and trypanosomiasis research and control activities include, Programme against African Trypanosomiasis (PAAT), World Health Organization (WHO), United Nations Food and Agriculture Organization (FAO) and International Atomic Energy Agency (IAEA) as well as National institutions, Universities, International NGOs and research institutions such as Centre International de Recherché-Développement sur I'Elevage en zone Subhumide (CIRDES), International Centre for Insect Physiology and Ecology (ICIPE), International Livestock Research Institute (ILRI) and the International Trypanosomiasis Center (ITC). It is, however, of concern that most of these Institutions, that were very active in research and control of Trypanosomiases, have either stopped the activities or are operating at very low levels due to low funding.

Your Excellency, the Vice President

At this juncture, it is imperative to pose a critical question to all stakeholders on the way forward in tsetse and trypanosomiasis control and elimination on the continent. Can we afford to continue this way while trypanosomiasis continues to threaten the health of humans and animals in rural areas constraining not only rural development but also tourism on the continent?

It is my humble desire to appeal to all of you, National governments and institutions, the international community including NGOs, international organization, donors and other stakeholders to respond effectively to the call and refocus our concerted efforts and synergies towards research, control and elimination of tsetse and trypanosomiasis.

Looking back, you would recall that control of African trypanosomiasis in Africa has been undertaken since the 20th Century, when the negative impact of the disease on human and animal health was recognised. These early efforts led to drastic reduction of the disease. However, the reduced burden of the disease led to a declining interest among the public sector authorities and other partners in investing in the control of the disease. Unfortunately, this lull led to the re-emergence of the disease and in the 80's to the 90's the disease had re-gained its hold in areas where it had earlier been controlled and as such heavy losses in livestock were registered with accompanying adverse impact on public health. The upsurge led to the creation PATTEC aimed at elimination and eventual eradication of tsetse and trypanosomiasis in the 38 states of Africa infested with the tsetse fly vector. Since the creation of the PATTEC initiative, a lot of efforts and gains have been made in the control of trypanosomiasis. However, more needs to be done. We need to reflect on the key issues and lessons learned that will guide our strategies and operations in Tsetse and Trypanosomiasis research and control in years ahead. We must never relent again!

Your Excellency, Ladies and Gentlemen

Although the number of reported cases of Human African Trypanosomiasis has reduced to below 3,000 per year. I urge you not to lower your guard and remain vigilant as previous periods of low disease levels have been followed by resurgence of the disease. I would, therefore, urge you and in particular the World Health Organisation (WHO) and other Institutions to:

- Sustain efforts to support the control of Human African Trypanosomiasis ;
- Work in close collaboration with AU-PATTEC and AU-IBAR in efforts aimed at vector control;
- Enhance advocacy on the disease with emphasis on the sensitisation of policy makers so that the elimination of Human African Trypanosomiasis is treated as a high priority issue;

Guest of Excellency, Ladies and Gentlemen,

For effective and sustainable tsetse and trypanosomiasis research and control, we need to capitalise on some of the lessons we have learned along the way. Past experiences, show that tsetse and trypanosomiasis control activities are effective when integrated with other rural development activities. I urge you, therefore, to institutionalize Tsetse and Trypanosomiasis control activities in the National and Regional Comprehensive Africa Agriculture Development Programme (CAADP) Investment Plans when they are being formulated or

revised. CAADP provides a framework for national consultation processes. Countries should also include tsetse and trypanosomiasis control in the Poverty Reduction Strategies to ensure mainstreaming of trypanosomiasis control and sustainable livelihoods at the community level.

A window of opportunity now exists whereby the current broader understanding of tsetse ecology and behaviour has made it possible to integrate a combination of two or more technologies in area-wide pest management approaches. For sustainable solutions to the challenges of tsetse and trypanosomiasis, control projects need to embrace this approach. There is no silver bullet and integrated approaches are the way to go. I am happy to observe that the projects currently being implemented within the framework of PATTEC have embraced this approach and this is something which others must capitalise on to be successful.

Your Excellency, Ladies and gentlemen

Availability of quality data continues to be a challenge in evidence based decision making in tsetse and trypanosomiasis research and control. Reliable data and information supports targeting of interventions, thereby bringing in efficiency of the interventions and curbing the misuse of trypanocides. I urge you to advocate and promote investments in quality data collection and analysis to inform tsetse and trypanosomiasis interventions.

In addition, new novel technologies and tools to control trypanosomiasis need to be generated through operational research. Further, in the wake of climate change and climate variability, I suggest that research should also be undertaken to highlight the effect of climate change on tsetse distribution and the impact on tsetse and trypanosomiasis control.

Allow me to congratulate the Secretariat of the Council based at AU-IBAR because we will apply current technologies during the 34th ISCTRC general conference to try and connect remote participants who for one reason or another could not physically attend the meeting. The use of Cisco WebEx, will greatly enhance the participation of many Africans by enhancing the dissemination of T&T information, conservation and documentation.

Your Excellency, distinguished participants,

Before I conclude, I wish to convey special thanks to the Government and People of Zambia for accepting to host this conference in this beautiful historical tourist City of Livingstone. Indeed, this is the most appropriate environment for scientists and policy makers to interact and deliberate on practical solutions to resolve the issue of tsetse and trypanosomiases. We sincerely appreciate the hospitality and the arrangements that you have made for this important occasion including provision of these magnificent conference facilities. Let me take this opportunity, on behalf of the Chairperson of the African Union Commission, His Excellency Moussa Faki Mahamat, H.E. Mrs. Josefa Sacko, Commissioner for Rural Economy and Agriculture, and on my own behalf, to thank you all and wish you successful deliberations.

Thank you.

DISCOURS PRINCIPAL PAR S.E. MADAME JOSEFA SACKO COMMISSAIRE DE L'UNION AFRICAINE À L'ÉCONOMIE RURALE ET À L'AGRICULTURE

- Excellence, Très Honorable Madame Inonge Wina, Vice-présidente de la République de Zambie,
- Monsieur le Ministre de la Pêche et de l'Élevage, Honorable Michael Katambo,
- Monsieur le Ministre de la Province du Sud, Honorable Dr Edify Hamukale,
- Monsieur le Maire de Livingstone, Conseiller Eugène Mapuwo,
- Vos altesses royales, Chefs traditionnels ici présents,
- Monsieur le Secrétaire permanent à la Pêche et à l'Élevage, Dr David Shamulenge,
- Monsieur le Secrétaire principal pour l'Agriculture et l'Élevage de la République du Kenya, Dr Andrew Tuimur,
- Mesdames et Messieurs les Membres du Corps diplomatique,
- Professeur Rahman, Président sortant du CSIRLT,
- Professeur Namangala, nouveau Président du CSIRLT,
- Mesdames et Messieurs les Membres du Comité exécutif du CSIRLT,
- Mesdames et Messieurs les Représentants des organisations internationales,
- Distingués Délégués et Participants,
- Éminents Scientifiques,
- Mesdames et Messieurs les Membres du Comité national d'organisation,
- Distingués Invités,
- Mesdames et Messieurs,

Nous voudrions commencer par adresser nos souhaits de bienvenue à notre conférence à Son Excellence Madame la Vice-présidente de la République de Zambie. Excellence, nous nous réjouissons de votre présence parmi nous, et par votre intermédiaire, je voudrais exprimer ma gratitude à l'endroit du Gouvernement et du Peuple de la République de Zambie pour leur collaboration avec la Commission de l'Union africaine à l'organisation et à la convocation de la 34ème Conférence générale du Conseil scientifique international pour la recherche et la lutte contre les trypanosomiases (CSIRLT) et de la 16ème Réunion des coordinateurs nationaux du programme PATTEC, ainsi que pour

l'accueil chaleureux et la généreuse hospitalité dont ils nous ont témoignés. Nous adressons également nos remerciements à nos partenaires en coopération présents à cette rencontre.

Je souhaite également la bienvenue à tous les délégués représentant nos États membres, les organisations internationales et les instituts de recherche, et à tous les participants à cette importante conférence.

Placée sous le thème « Exploiter les progrès accomplis dans la lutte contre les trypanosomiases humaine et animale en partenariat avec toutes les parties prenantes – perspectives d'avenir », cette conférence intervient à un moment opportun, puisque le Conseil scientifique international pour la recherche et la lutte contre les trypanosomiases (CSIRLT) a maintenant 68 ans. Après ces 68 ans de lutte contre la mouche tsé-tsé et la trypanosomiase, il est temps de se réunir pour faire le bilan des progrès substantiels accomplis en termes d'arrangements institutionnels, de recherche, de technologies disponibles, d'approches, de partenariats, d'investissements et de leçons apprises afin de maîtriser la mouche tsé-tsé et la trypanosomiase en Afrique.

La mouche tsé-tsé et la trypanosomiase continuent de poser un problème énorme dans les zones rurales d'Afrique. La ceinture des glossines s'étend sur environ 10 millions de kilomètres carrés répartis sur 38 pays africains. Cette région représente un tiers du continent africain! Dans cette ceinture, 50 millions de bovins vivent à l'intérieur ou à la périphérie des zones infestées de glossines et sont exposés au risque de trypanosomiase animale africaine. Les pertes dues à la trypanosomiase animale africaine sont considérables et sont estimées à 5 milliards de dollars américains par an. Ces pertes entravent le développement du secteur de l'élevage sur le continent et l'atteinte des objectifs de la Déclaration de Malabo sur la transformation de l'agriculture, voire ceux de l'Agenda 2063 qui cherchent à atteindre « l'Afrique que nous voulons ». Plus précisément, le fléau que sont les glossines et les trypanosomiases, s'il n'est pas combattu, sera un obstacle à la bonne mise en œuvre de la Stratégie de développement de l'élevage pour l'Afrique (LiDeSA).

La maladie du sommeil continue de poser un risque pour la santé publique dans de nombreuses régions rurales d'Afrique. On estime à environ 60 millions de personnes la population à risque ; et 2 000 cas de maladie du sommeil sont signalés chaque année.

Excellence Madame la Vice-présidente,

Monsieur le Ministre,

Distingués Délégués et Participants,

La volonté de coordonner et d'harmoniser les efforts en matière de recherche et de lutte contre les glossines et les trypanosomiases à cause de la nature transfrontalière de la maladie et du besoin d'efficacité et de rationalité dans la mise en œuvre des interventions de lutte contre les glossines et les trypanosomiases, a conduit à la création du Conseil scientifique international pour la recherche et la lutte contre les trypanosomiases (CSIRLT) en 1949. Le secrétariat du Conseil se trouve au Bureau interafricain des ressources animales de l'Union africaine (UA-BIRA) à Nairobi, capitale du Kenya.

Les chefs d'État et de gouvernement ont encore manifesté la volonté de déployer des efforts collectifs dans ce domaine en 2000, lorsque, constatant la grave menace posée par les épidémies de trypanosomiase des années 1990 à la santé humaine et animale qui étaient susceptibles de compromettre le développement rural, ont mis en place la Campagne panafricaine d'éradication des glossines et des trypanosomoses (PATTEC). Il s'agit d'un programme qui couvre l'ensemble du continent et vise des efforts conjoints et des activités de collaboration à l'échelle nationale pour contrôler et éliminer les glossines et les trypanosomiases dans les 38 pays africains infestés.

Les autres institutions qui participent ou ont participé aux activités de recherche et de lutte contre les glossines et les trypanosomiases comprennent le Programme de lutte contre la trypanosomiase africaine (PLTA), l'Organisation mondiale de la santé (OMS), l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO) et l'Agence internationale de l'énergie atomique (AIEA), ainsi que des institutions nationales, des universités, des ONG internationales et des instituts de recherche tels que le Centre international de recherche sur le développement de l'élevage en zone subhumide (CIRDES), le Centre international de physiologie et d'écologie des insectes (ICIPE), l'Institut international de recherche sur l'élevage (ILRI)) et le Centre international de trypanotolérance (ITC). Cependant, il est préoccupant de constater que la plupart de ces institutions, jadis très actives dans la recherche et la lutte contre les trypanosomiases, ont arrêté les activités ou fonctionnent d'une manière très limitée en raison de faibles niveaux de financement.

Excellence Madame la Vice-Présidente,

À l'heure actuelle, il est impératif de poser une question cruciale à toutes les parties prenantes sur les moyens d'accomplir des progrès dans le contrôle et l'élimination des glossines et des trypanosomiases sur le continent. Pouvons-

nous nous permettre de continuer sur cette voie alors que la trypanosomiase constitue toujours une menace à la santé humaine et animale dans les zones rurales, entravant non seulement le développement rural mais également le tourisme sur le continent ?

Je voudrais humblement lancer un appel à vous tous, aux Gouvernements et institutions nationales, à la communauté internationale, y compris les ONG, les organisations internationales, les bailleurs de fonds et les autres parties prenantes, et je vous prie de répondre efficacement à cet appel et de recentrer nos efforts concertés et nos synergies sur la recherche, le contrôle et l'élimination des glossines et des trypanosomiases.

Vous vous souviendrez que la lutte contre la trypanosomiase africaine en Afrique a commencé au 20ème siècle, à la suite de la reconnaissance de l'impact négatif de la maladie sur la santé humaine et animale. Ces premiers efforts ont conduit à une forte réduction de la maladie. Cependant, la réduction de la charge de la maladie a entraîné une perte de l'intérêt des autorités du secteur public et des autres partenaires à investir dans la lutte contre ce fléau. Malheureusement, cette perte d'intérêt a provoqué la réapparition de la maladie et, dans les années 80 - 90, la maladie a repris son emprise dans les zones où elle avait été précédemment contrôlée. Ainsi, de lourdes pertes d'animaux ont été enregistrées, avec un impact négatif sur la santé publique. La recrudescence de la maladie a conduit à la mise en place du programme PATTEC, en vue de l'élimination et de l'éradication définitive des glossines et des trypanosomiases dans les 38 États d'Afrique infestés par la mouche tsé-tsé, vecteur de la maladie. Depuis la création de l'initiative PATTEC, de nombreux efforts ont été déployés dans la lutte contre la trypanosomiase et des progrès ont été accomplis. Cependant, beaucoup reste à faire dans ce domaine. Nous devons réfléchir aux principaux problèmes et enseignements tirés qui guideront nos stratégies et nos opérations de recherche et de lutte contre les glossines et les trypanosomiases dans les années à venir. Nous ne devons plus jamais relâcher nos efforts !

Excellence, Mesdames et Messieurs,

Même si le nombre de cas de trypanosomiase humaine africaine signalés est tombé à moins de 3 000 par an, je vous exhorte à ne pas baisser la garde et à rester vigilants car les périodes précédentes de faible taux ont été suivies d'une résurgence de la maladie. Par conséquent, je vous exhorte, et en particulier l'Organisation mondiale de la santé (OMS) et d'autres institutions, à :

- poursuivre les efforts de lutte contre la trypanosomiase humaine africaine ;
- travailler en étroite collaboration avec l'UA-PATTEC et l'UA-BIRA dans les efforts de lutte antivectorielle ;
- renforcer le plaidoyer pour la lutte contre la maladie en mettant l'accent sur la sensibilisation des responsables de l'élaboration des politiques, afin que l'élimination de la trypanosomiase humaine africaine soit traitée comme une question hautement prioritaire.

Excellence, Mesdames et Messieurs,

Pour que la recherche et la lutte contre la mouche tsé-tsé et la trypanosomiase soient efficaces et durables, nous devons tirer parti de certaines leçons que nous avons apprises au fil du temps. Les expériences passées montrent que les activités de lutte contre la mouche tsé-tsé et la trypanosomiase sont efficaces lorsqu'elles sont intégrées à d'autres activités de développement rural. Je vous exhorte donc à institutionnaliser les activités de lutte contre la mouche tsé-tsé et la trypanosomiase dans les plans d'investissement nationaux et régionaux du Programme détaillé de développement de l'agriculture en Afrique (PDDAA) lors de leur formulation ou de leur révision. Le PDDAA fournit un cadre pour les processus de consultation nationaux. Les pays devraient également inclure la lutte contre la mouche tsé-tsé et la trypanosomiase dans les stratégies de réduction de la pauvreté afin d'assurer l'intégration de la lutte contre la trypanosomiase et la durabilité des moyens de subsistance au niveau communautaire.

Il faut tirer parti de la possibilité actuellement offerte : la meilleure compréhension actuelle de l'écologie et du comportement des mouches tsé-tsé a permis d'intégrer une combinaison de deux ou plusieurs technologies dans des approches de lutte antiparasitaire à l'échelle régionale. Pour que des solutions durables aux problèmes posés par les glossines et la trypanosomiase soient trouvées, les projets de contrôle doivent adopter cette approche. Il n'y a pas de solution miracle et les approches intégrées sont la voie à suivre. Je suis heureuse de constater que les projets en cours de mise en œuvre dans le cadre de l'initiative PATTEC ont adopté cette approche, et les autres doivent suivre cet exemple pour porter des fruits.

Excellence, Mesdames et Messieurs,

La disponibilité de données de qualité reste un défi pour la prise de décisions fondées sur des informations factuelles dans la recherche et le contrôle de la mouche tsé-tsé et de la trypanosomiase. La fiabilité des données et des informations permet de cibler les interventions et, partant, de les rendre plus efficaces, et de limiter l'utilisation abusive des trypanocides. Je vous exhorte à défendre et à promouvoir les investissements dans la collecte et l'analyse des données de qualité pour éclairer les interventions de lutte contre la mouche tsé-tsé et la trypanosomiase.

En outre, Il faudra générer de nouvelles technologies et de nouveaux outils de lutte contre la trypanosomiase à travers la recherche opérationnelle. De plus, dans le contexte du changement climatique et de la variabilité climatique, je propose que des recherches soient également menées pour mettre en évidence l'effet du changement climatique sur la distribution de la mouche tsé-tsé et son impact sur la lutte contre les glossines et les trypanosomiases.

Permettez-moi de féliciter le Secrétariat du Conseil basé à l'UA-BIRA, car nous mettrons en application les technologies actuelles lors de la 34ème Conférence générale du CSIRLT pour essayer de connecter des participants distants se trouvant, pour une raison ou une autre, dans l'impossibilité d'assister physiquement à la réunion. L'utilisation de Cisco WebEx renforcera considérablement la participation de nombreux Africains en améliorant la diffusion des informations sur les T & T, la conservation et la documentation.

Excellence, Distingués Participants,

Avant de terminer, je voudrais remercier tout particulièrement le Gouvernement et le Peuple de la Zambie d'avoir accepté d'accueillir cette conférence dans cette magnifique ville touristique historique de Livingstone. En effet, c'est l'environnement qui convient le mieux aux scientifiques et aux responsables de l'élaboration des politiques souhaitant échanger leurs idées et débattre des solutions pratiques au problème posé par la mouche tsé-tsé et la trypanosomiase. Nous apprécions vivement l'hospitalité que vous avez manifestée et les dispositions prises pour cette occasion importante, notamment la mise à disposition de ces magnifiques salles de conférence. Permettez-moi de saisir cette occasion, au nom du Président de la Commission de l'Union africaine, Son Excellence Moussa Faki Mahamat, de S.E. Madame Josefa Sacko, Commissaire à l'Économie rurale et à l'Agriculture, et en mon nom personnel, pour vous remercier tous et vous souhaiter plein succès dans vos travaux.

Je vous remercie.

REMARKS BY THE COMMISSIONER/DIRECTOR OF RURAL ECONOMY AND AGRICULTURE AT THE INAUGRAL DINNER FOR THE 34TH ISCTRC CONFERENCE

LIVINGSTONE, ZAMBIA

- Your Excellency, the President of the Republic of Zambia, Mr. Edgar Chagwa Lungu;
- The Minister of Fisheries and Livestock, Hon. Micheal Katambo, MP;
- The Minister for Southern Province, Hon. Dr. Edify Hamukale, MP;
- The Mayor of the City of Livingstone, Councillor Eugene Mapuwo;
- Honorable Traditional Chiefs
- Representative of the Chairman of the ISCTRC Prof Rahman
- Executive Committee Members of the ISCTRC
- Representatives of International Organizations
- Eminent Scientists
- Members of the Diplomatic Corps
- The National Organizing Committee Members
- Distinguished Guest Participants in the 34th ISCTRC Conference
- Distinguished Guests
- Ladies and Gentlemen

Allow me, your Excellency to express, on behalf of the Chairperson of the African Union Commission, His Excellency Moussa Faki Mahamat, Her Excellency Josepha Sacko Correa, Commissioner for Rural Economy and Agriculture of the African Union Commission, my colleagues staff from the African Union Commission, particularly those from the African Union Interafrican Bureau for Animal Resources (AU-IBAR) and the African Union Panafrican Tsetse and Trypanosomisis Eradication Campaign (AU-PATTEC), and indeed on my own behalf, to express our utmost delight at being here in Livingstone Zambia and sharing this privileged moment with you all. We are all immensely grateful to your Excellency, your government and the people of Zambia for accepting to host the 34th Conference of the International Scientific Council for Trypanosomiasis Research and Control, for the tremendous resources and preparations that that have gone into this conference and for this dinner that you have invited us to this evening.

Indeed the issues surrounding Tsetse and Typanosomisis are so important to us in African because of the devastating socio-economic effects that the diseases possess to most of our people, particularly those in the rural areas. In Zambia the vector has caused immerse loss of both human and animal life and has rendered certain communities helpless, but I am happy to say that this country has over the years, true to its tradition of being a frontline state in this region, been in the forefront of the fight against the vector and the disease in both humans and animals. It is, therefore, befitting that this time around this extremely important conference is being hosted by your country.

Your Excellency, we will talk more about this vector and the disease from tomorrow. This evening we are all here to enjoy the famous hospitality and generosity of the Zambian people and it is therefore not time to belabor the technical issues and the effects of tsetse and trypanosomiasis. Suffice to say that the African union Commission is fully committed to ensuring that these two are completely eradicated from the continent of Africa, in order to ensure that all our people, especially the rural dwellers and the tour operators thrive in their endeavors unhindered.

TOAST

Permit me your Excellency to toast to your good health and your continued wise leadership, not only of the country of Zambia, but also of your efforts in supporting the development of animal resources in general and animal disease control in particular.

To your Excellency

Thank you very much.

ALLOCUTION DE LA COMMISSAIRE / DIRECTEUR DE L'ÉCONOMIE RURALE ET DE L'AGRICULTURE LORS DU DÎNER INAUGURAL DE LA 34ÈME CONFÉRENCE DU CSIRLT TENUE À LIVINGSTONE EN ZAMBIE

- Excellence Monsieur Edgar Chagwa Lungu, Président de la République de Zambie,
- Monsieur le Ministre de la Pêche et de l'Élevage, Honorable Micheal Katambo,
- Monsieur le Ministre de la Province du Sud, Honorable Dr Edify Hamukale,
- Monsieur le Maire de la ville de Livingstone, Conseiller Eugène Mapuwo,
- Honorables Chefs traditionnels,
- Prof Rahman, Représentant du Président du CSIRLT,
- Mesdames et Messieurs les Membres du Comité exécutif du CSIRLT,
- Éminents Scientifiques,
- Mesdames et Messieurs les Membres du Corps diplomatique,
- Mesdames et Messieurs les Membres du Comité national d'organisation,
- Éminents Participants à la 34ème Conférence du CSIRLT,
- Distingués Invités,
- Mesdames et Messieurs,

Permettez-moi d'exprimer, au nom du Président de la Commission de l'Union africaine, Son Excellence Moussa Faki Mahamat, de la Commissaire de l'Union africaine à l'Économie rurale et à l'Agriculture, Son Excellence Josepha Sacko Correa, de mes collègues de la Commission de l'Union africaine, en particulier ceux du Bureau interafricain des ressources animales de l'Union africaine (UA-BIRA) et de la Campagne panafricaine de l'Union africaine pour l'éradication des glossines et des trypanosomiames (UA-PATTEC), et en mon propre nom, d'exprimer notre grand plaisir d'être ici Livingstone en Zambie et de partager ce moment privilégié avec vous tous. Nous sommes tous extrêmement reconnaissants à Votre Excellence, à votre Gouvernement et au Peuple zambien d'avoir accepté d'accueillir la 34ème Conférence du Conseil scientifique international pour la recherche et la lutte contre les trypanosomiases, pour les préparatifs et les ressources considérables consacrées à l'organisation de cette conférence et pour ce dîner auquel que vous nous avez conviés ce soir.

En effet, les problèmes liés aux mouches tsé-tsé et aux trypanosomiases sont très importants pour nous en Afrique en raison des effets socio-économiques dévastateurs que ces maladies ont sur la plupart de nos habitants, en particulier ceux des zones rurales. En Zambie, le vecteur de ces maladies a provoqué d'immenses pertes de vies humaines et animales et rendu certaines communautés très vulnérables, mais je suis heureuse de dire que ce pays a maintenu, au fil des ans, sa tradition d'être à l'avant-garde de la lutte contre le vecteur et la maladie chez l'homme et chez l'animal dans cette région. Il est donc convenable que cette conférence extrêmement importante soit cette fois-ci accueillie par votre pays.

Excellence, nous parlerons davantage de ce vecteur et de la maladie à partir de demain. Ce soir, nous sommes tous ici pour profiter de la célèbre hospitalité et générosité du peuple zambien, et ce n'est donc pas le moment de réfléchir aux problèmes techniques et aux effets de la mouche tsé-tsé et de la trypanosomiase. Pour le moment, il est suffisant de dire que la Commission de l'Union africaine est fermement résolue à éradiquer complètement ces deux problèmes du continent africain, afin de permettre à tous nos peuples, en particulier les habitants des zones rurales et les tour-opérateurs, de prospérer dans leurs activités.

TOAST

Permettez-moi, Excellence, de porter un toast à votre santé et à votre leadership avisé, non seulement de votre pays la Zambie, mais également de vos efforts de soutien au développement des ressources animales en général et au contrôle des maladies animales en particulier.

À Votre Excellence !

Je vous remercie beaucoup.

OFFICIAL OPENING OF THE 34TH AFRICAN UNION (AU) INTERNATIONAL SCIENTIFIC COUNCIL FOR TRYPANOSOMIASIS RESEARCH AND CONTROL CONFERENCE BY HIS EXCELLENCY, THE PRESIDENT OF REPUBLIC OF ZAMBIA, MR EDGAR CHAGWA LUNGU

- THE ROYAL HIGHNESSES PRESENT
- THE AFRICAN UNION COMMISSIONER FOR RURAL ECONOMY AND AGRICULTURE HER EXCELLENCY – JOSEFA LEONEL CORREIA SACKO
- MINISTER OF FISHERIES AND LIVESTOCK- HON M. KATAMBO
- MINISTER FOR SOUTHERN PROVINCE – HON DR EDIFY HAMUKALE
- THE PERMANENT SECRETARY FOR FISHERIES AND LIVESTOCK – DR DAVID SHAMULENGE
- THE PERMANENT SECRETARY FOR SOUTHERN PROVINCE - MR SIMUCHOBA
- THE SOUTHERN PROVINCE PF PROVINCIAL CHAIRMAN – MR gmLAWRENCE EVANS
- DIRECTOR FOR AU-IBAR – PROF AHMED SAWAHLY
- HIS LORDSHIP THE MAYOR OF LIVINGSTONE
- SENIOR GOVERNMENT OFFICIALS PRESENT
- DISTINGUISED DELEGATES (LOCAL AND INTERNATIONAL)
- MEMBERS OF THE PRESS
- LADIES AND GENTLEMEN

On behalf of the Zambian people, i wish to welcome you all to our beautiful country and its friendly people. I further wish to welcome you to this 34th African Union (AU) international scientific council for trypanosomiasis research and control conference that is being hosted by my government here in Livingstone. I wish to thank the African union interafrican bureau for animal resources for choosing Zambia and Livingstone in particular, to host this important conference. This is because in addition to the knoweldge you will gain, you also get to enjoy the hospitality of Zambia's tourism capital.

Ladies and Gentlemen

Zambia is diversifying its economy from mining to agriculture with emphasis on cash crops, fisheries and livestock production. To walk the talk, my government has initiated several reforms. A few weeks back on 21st June 2017, my government launched the seventh national development plan (7NDP) to run from 2017 to 2021. The main goal of the 7NDP is "to create a diversified and resilient economy for sustained higher growth and socio-economic development." The innovation of the 7ndp is that it is an integrated multi-sectoral planning approach to deal with the interdependence between various sectors; it also creates a more coordinated and efficient approach to implementing developmental programmes; further, it targets the country's economic potential, competitiveness and comparative advantages and furthermore, it identifies national development strategic areas (DSA) which all sectors can focus on. The prevention and control of hat and eradication of tsetseflies that this conference targets speaks directly to the 7thndp dsa of;

1. Economic diversification and job creation;
2. Enhanced human development;
3. Reducing development inequalities;
4. Creating a conducive governance environment for a diversified economy;

Therefore, hosting of this conference by Zambia is in line with government priorities and a clear testimony of the importance this government attaches to animal disease control and agriculture.

Ladies and Gentlemen

I am told the theme of this conference is "capitalising on the progress made against human and animal trypanosomiasis – the way forward in partnership with all stakeholders" is very timely for zambia and could not have come at a better time when the country is facing numerous threats to its prized resource (the animal and human capital) from diseases like trypanosomiasis and pests like tsetse flies. As some of you may know about 40% of the Zambia's land area is infested with tsetse flies that impedes livestock production and agricultural expansion. These areas include eastern, Kafue, lower Zambezi, Kwando Zambezi, bangweulu and mweru wantipa tsetse belts. The eastern tsetse belt is the most significant recording the highest number of animal and human trypanosomiasis cases. It covers approximately 80,000 square kilometers in parts of the eastern, muchinga, central, and Lusaka provinces. This tsetse belt also extends into three neighbouring countries of Malawi, Mozambique and Zimbabwe. You know better that tsetse flies transmit trypanosomiasis to animals and humans. About 60% of the country's traditional herd of cattle is at risk of infection with trypanosomiasis and so is the population of goats

and sheep found in the respective areas. Dogs and pigs are also susceptible to the disease. Human African trypanosomiasis (HAT), commonly referred to as sleeping sickness affects over 100 people per year. In recent years, there has been an increase in reported cases of hat among tourists visiting the country's major national parks demonstrating the significant threat of the disease on the tourism sector. Therefore, my government supports initiatives like this conference and is looking for partnerships (local, bilateral or multilateral) to deal with trypanosomiasis danger to the livestock sector.

Ladies and Gentlemen

Trypanosomiasis is a serious chronic disease of animals and humans in sub-saharan Africa that causes enormous economic losses by severely depressing livestock production and productivity through reduced conception and birth rates; meat, milk, manure, hides and skins production as well as draft power availability. In humans, the disease is usually mistaken for malaria therefore increasing time spent seeking medical attention. This results in reduced production capacity leading to increased burden on families, communities and health care systems. If untreated, trypanosomiasis leads to death in all infected animals or humans. Therefore, trypanosomiasis directly or indirectly impacts negatively on agriculture and rural livelihoods. The disease is usually described as a neglected disease that has received little attention despite its net effects on the communities and the economy at large.

Ladies and gentlemen

I am aware that in the year 2000 in Lome, Togo, the African heads of states and governments, made a declaration that the continent should embark on elimination of the trypanosomiasis problem in the best way and shortest time possible. I am informed that efforts have been made in the past to eradicate tsetse flies and trypanosomiasis from the African continent however, this has not been achieved. I have been informed also that the necessary knowledge, skills, technologies exist to be able to eliminate this problem. The question i am asking you the organisers and the delegates is what is it that we have not done right? What lessons can we draw to help deal with the future? What do we need to do as a country, as a region like sadc, and indeed as a continent?

This conference i have been told offers a platform for us to collectively take stock and reflect on why this disease continues to be such a huge burden on us in this time and era. History teaches us that it is not enough to have the desire but good plans to achieve something. I am employing you the experts to

provide a clear succint roadmap of how this problem will be eradicated from the African continent. The time to act is now.

Ladies and gentlemen

As i conclude, let me emphasize that the African continent is looking up to this conference specifically to you all for solutions on what needs to be done to eradicate trypanomiasis. I wish to re-affirm my governments commitment to eradicating tsetseflies and trypanomiasis from zambia in particular and the african continent in general.

It is now my singular honour and priviledge to declare this conference officially open and wish you a fruitful deliberation.

I thank you and God bless you all

OUVERTURE OFFICIELLE DE LA 34ÈME CONFÉRENCE DU CONSEIL SCIENTIFIQUE INTERNATIONAL POUR LA RECHERCHE ET LA LUTTE CONTRE LES TRYPANOSOMIASES PAR SON EXCELLENCE, LE PRESIDENT DE LA REPUBLIQUE DE ZAMBIE, MONSIEUR EDGAR CHAGWA LUNGU

- VOS ALTESSES ROYALES ICI PRÉSENTES,
- EXCELLENCE MADAME JOSEFA LEONEL CORREIA SACKO, COMMISSAIRE DE L'UNION AFRICAINE À L'ECONOMIE RURALE ET À L'AGRICULTURE,
- EXCELLENCE MONSIEUR KATAMBO, MINISTRE DE LA PÊCHE ET DE L'ÉLEVAGE,
- EXCELLENCE DR EDIFY HAMUKALE, MINISTRE DE LA PROVINCE DU SUD,
- MONSIEUR LE SECRÉTAIRE PERMANENT À LA PÊCHE ET ÀL'ÉLEVAGE, DR DAVID SHAMULENGE,
- MONSIEUR SIMUCHOBA, SECRÉTAIRE PERMANENT POUR LA PROVINCE DU SUD,
- MONSIEUR LAWRENCE EVANS, PRÉSIDENT PROVINCIAL DU FP POUR LA PROVINCE DU SUD,
- MONSIEUR LE DIRECTEUR DE L'UA-BIRA, PROFESSEUR AHMED SAWAHLY,
- MONSIEUR LE MAIRE DE LIVINGSTONE,
- HONORABLES HAUTS RESPONSABLES DU GOUVERNEMENT ICI PRÉSENTS,
- DISTINGUÉS DÉLEGUÉS (LOCAUX ET INTERNATIONAUX),
- MESDAMES ET MESSIEURS LES MEMBRES DE LA PRESSE,
- MESDAMES ET MESSIEURS,

Au nom du Peuple zambien, je voudrais d'abord vous souhaiter à tous la bienvenue dans notre beau pays et parmi nos très hospitaliers citoyens, et de vous accueillir à cette 34ème Conférence du Conseil scientifique international pour la recherche et la lutte contre les trypanosomiases, organisée par mon Gouvernement ici à Livingstone. Je saisis cette occasion pour remercier le Bureau interafricain des ressources animales de l'Union africaine d'avoir choisi la Zambie, et plus particulièrement Livingstone, pour l'accueil de cette importante conférence. Outre les connaissances que vous allez acquérir, vous aurez également l'opportunité d'apprécier l'hospitalité de la capitale

touristique de la Zambie.

Mesdames et Messieurs,

La Zambie est engagée dans un processus de diversification de son économie, de l'exploitation minière à l'agriculture, avec un accent particulier sur les cultures commerciales, la pêche et l'élevage. Plus précisément, mon Gouvernement a entamé plusieurs réformes. En effet, le 21 juin 2017, mon Gouvernement a lancé le septième Plan national de développement (7ndp) pour la période 2017 - 2021. Le principal objectif du 7ndp est de « créer une économie diversifiée et résiliente pour soutenir un niveau plus élevé de croissance et de développement socioéconomique ». L'innovation du 7ndp réside dans son approche de planification multisectorielle intégrée pour aborder l'interdépendance entre différents secteurs ; il crée également une approche plus coordonnée et efficace pour la mise en œuvre des programmes de développement. En outre, il cible le potentiel économique, la compétitivité et les avantages comparatifs du pays, et identifie les domaines stratégiques nationaux de développement sur lesquels tous les secteurs peuvent se focaliser. La prévention et le contrôle de la THA et l'éradication de la mouche tsé-tsé, objectifs visés par cette conférence, concernent directement les domaines stratégiques du 7ndp pour le développement, à savoir :

1. la diversification économique et la création d'emplois ;
2. l'amélioration du développement humain ;
3. la réduction des inégalités en matière de développement ;
4. la création d'un environnement de gouvernance favorable à une économie diversifiée.

Par conséquent, l'accueil de cette conférence par la Zambie est conforme aux priorités gouvernementales et un témoignage fort de l'importance que ce gouvernement attache au contrôle des maladies animales et à l'agriculture.

Mesdames et Messieurs,

On me dit que cette conférence est organisée sous le thème « Exploiter les progrès accomplis dans la lutte contre les trypanosomiases humaine et animale en partenariat avec tous les parties prenantes – perspectives d'avenir ». La conférence arrive à point nommé pour la Zambie, car en ce moment le pays est confronté à de nombreuses menaces pour ses précieuses ressources (capital animal et humain), menaces liées aux maladies comme la trypanosomiase

et aux parasites tels que la mouche tsé-tsé. Comme certains d'entre vous le savent, 40% du territoire de la Zambie est infesté de mouches tsé-tsé, lesquelles constituent une entrave à la production animale et à l'expansion agricole. Ces zones comprennent les ceintures des glossines – Est, Kafue, Haut Zambèze, Kwando Zambezi, Bangweulu et Mweru Wantipa. La ceinture orientale des tsé-tsé est la plus importante car elle enregistre le plus grand nombre de cas de trypanosomiases animale et humaine. Elle couvre approximativement 80 000 kilomètres carrés des parties des provinces Est, Muchinga, Centre et Lusaka. Cette ceinture de glossines s'étend également à trois pays voisins, à savoir le Malawi, le Mozambique et le Zimbabwe. Vous savez bien que la mouche tsé-tsé transmet la trypanosomiase aux animaux et à l'homme. Près de 60% des effectifs bovins traditionnels du pays sont exposés au risque d'infection par la trypanosomiase, et il en est de même pour la population de caprins et d'ovins qu'on trouve dans les diverses régions. Les chiens et les porcs sont également vulnérables par rapport à la maladie. La trypanosomiase humaine africaine (THA), communément appelée maladie du sommeil, affecte plus de 100 personnes par an. Au cours des dernières années, on a noté une augmentation du nombre de cas parmi les touristes visitant les principaux parcs nationaux du pays, une preuve manifeste de la gravité de la menace de la maladie sur le secteur touristique. En conséquence, mon Gouvernement soutient les initiatives telles cette conférence et cherche à établir des partenariats (locaux, bilatéraux ou multilatéraux) pour faire face au danger que pose la trypanosomiase au secteur de l'élevage.

Mesdames et Messieurs,

La trypanosomiase est une maladie chronique grave qui affecte les animaux et l'homme en Afrique subsaharienne, provoque des pertes économiques énormes du fait qu'elle réduit la production et la productivité animales en raison de la diminution des taux de conception et de mise bas, et engendre des baisses de production de viande, de lait, de bouse, de peaux et cuirs, et d'animaux de trait. Chez l'homme, la maladie est également confondue avec le paludisme, et accroît ainsi le temps passé à la recherche de l'attention médicale. Il en résulte une réduction des capacités de production qui conduit à l'alourdissement de la charge de la maladie sur les familles, les communautés et les systèmes de soins de santé. Si elle n'est pas traitée, la trypanosomiase conduit à la mort chez tous les animaux ou humains infectés. Par conséquent, la trypanosomiase a des effets négatifs directs ou indirects sur l'agriculture -moyen de subsistance des communautés rurales. La maladie est également décrite comme une maladie négligée qui reçoit peu d'attention en dépit de ses effets nets sur les communautés et l'économie dans son ensemble.

Mesdames et Messieurs,

Je sais qu'en 2000 à Lomé (Togo), les chefs d'État et de gouvernement africains ont déclaré que le continent devrait se lancer dans l'élimination du problème de la trypanosomiase de la meilleure manière et dans les plus brefs délais possibles. On me dit que des efforts ont été déployés dans le passé pour éradiquer les mouches tsé-tsé et les trypanosomiases du continent africain ; cependant, cet objectif n'a pas été pleinement atteint. Il parait aussi que les connaissances, compétences et technologies nécessaires existent pour pouvoir éliminer ce problème. Maintenant, la question que je pose à vous organisateurs et délégués est celle-ci : que n'avons-nous pas fait comme il faut ? Quelles leçons pouvons-nous en tirer pour contribuer à résoudre le problème à l'avenir? Que devons-nous faire en tant que pays, en tant que région comme la SADC, et finalement en tant que continent ?

Cette conférence, m'a-t-on dit, nous donne l'occasion d'établir collectivement le bilan des progrès accomplis et de réfléchir sur les raisons de la persistance de cette maladie qui constitue un énorme fardeau pour nous en ce moment et pendant cette ère. L'histoire nous enseigne qu'il ne suffit pas d'avoir des souhaits, il faut surtout avoir de bons plans pour réaliser quelque chose. Je vous demande, vous les experts, de fournir une feuille de route succincte indiquant clairement la manière dont le problème sera éradiqué du continent africain. C'est maintenant que nous devons agir.

Mesdames et Messieurs,

Pour terminer, permettez-moi de souligner que le continent africain attend de cette conférence, et de vous plus particulièrement, des solutions qu'il faut mettre en oeuvre pour éradiquer la trypanosomiase. Je voudrais réitérer l'engagement de mon Gouvernement à éliminer la mouche tsé-tsé et la trypanosomiase de la Zambie en particulier et du continent africain en général.

J'ai maintenant l'honneur et le privilège de déclarer cette conférence officiellement ouverte, et je vous souhaite pleins succès dans vos travaux.

Je vous remercie. Que Dieu vous bénisse tous.

REPORTS AND RECOMMENDATIONS

RAPPORTS ET RECOMMANDATIONS

PRESENTATIONS BY INTERNATIONAL ORGANIZATIONS

Moderator: Bruce Mukanda

Rapporteur: Gift Wanda

During session 2, a keynote presentation was made on the ISCTRC 68 years' journey as a vehicle to promote international cooperation in the fight against T&T. The presentation revealed that the origins the ISCTRC date back to the trypanosomiasis epidemics that gave birth to the need for evidence-based action against T&T. The presentation highlighted the stages of evolution of ISCTRC to its present form with respect to membership of the council and committee, terms of reference and provisions of the constitution. The presentation also highlighted the key achievements registered by the council in its 68 years journey and the challenges encountered. The notable challenges include the increasing fragmented approach to the fight against T&T by partners and the inconsistent translation of political will on T&T into intervention programmes. The presentation proposed that as a way forward, T&T affected countries should take the lead in the fight while partners should focus their efforts on advocacy for resource mobilization to complement efforts of the national governments.

The presentation on ISCTRC was followed by presentations of international organizations. The presentations were received from FAO, WHO, IAEA, IRLI, ICIPE, CIRDES, FIND and DNDi in that order. Each organization highlighted their current and most recent contributions to the fight against T&T. After presentations, delegates sought clarification from ICIPE on research work being undertaken on camel trypanosomiasis, why DNDi registers drugs destined for use in Africa with European Drug Authorities, what WHO considers the key factors that have led to the drastic decline of HAT cases and how the public, private partnership approach has contributed to this this decline, on the correlation between the numbers of HAT cases and the quality of health facilities in Central African Republic and on the criteria used to select the beneficiary countries for the Trypa-NO! project.

Recommendations

1. Noting the increasing fragmented approach being pursued by partners in their efforts to contribute to the fight against T&T, it was recommended that ISCTRC and the PATTEC Coordination Office should develop multi-stakeholder partnership frameworks designed as a basis for partners' contributions to the fight against T&T.

2. Noting the apparent disconnect between T&T research and field operations and the increasing trends where some researchers and research institutions are doubling as field implementers, it is recommended that the ISCTRC should be used as the lead clearing house for translating T&T research work into field operations in order to recommend the institutions that are best placed to roll out the technologies generated from research work.

EXPOSÉS PRÉSENTÉS PAR LES ORGANISATIONS INTERNATIONALES

Modérateur : Bruce Mukanda

Rapporteur : Gift Wanda

Au cours de la deuxième session, un exposé thématique a été présenté sur le voyage de 68 ans du CSIRLT en tant qu'outil de promotion de la coopération internationale dans la lutte contre la mouche tsé-tsé et la trypanosomiase (T&T). L'exposé a révélé que les origines du CSIRLT remontent aux épidémies de trypanosomiase qui ont engendré la nécessité de mesures de lutte contre les T & T fondées sur des informations factuelles. L'exposé a mis en évidence les étapes du voyage du CSIRLT jusqu'à l'adoption de sa forme actuelle en ce qui concerne les membres du conseil et du comité, les attributions de ces derniers et les clauses des statuts. L'orateur a également mis en évidence les principaux résultats enregistrés par le Conseil tout au long de ses 68 ans d'existence ainsi que les défis rencontrés pendant ce voyage. Les défis importants comprennent la fragmentation croissante de l'approche de lutte contre les T & T utilisée par les partenaires et les divergences au niveau de la concrétisation de la volonté politique concernant les T & T en programmes d'intervention. L'orateur a proposé, comme lignes d'action, que les pays affectés par les T & T jouent le rôle de premier plan dans la lutte contre ce problème et que les partenaires concentrent leurs efforts sur le plaidoyer en faveur de la mobilisation des ressources pour compléter les efforts des gouvernements nationaux.

L'exposé sur le CSIRLT a été suivi d'exposés des organisations internationales, dans l'ordre ci-après : FAO, OMS, AIEA, IRLI, ICIPE, CIRDES, FIND et DNDi. Chaque organisation a souligné ses contributions actuelles et récentes à la lutte contre les T & T. Après les exposés, les délégués ont demandé des éclaircissements concernant les travaux de recherche en cours à l'ICIPE sur la trypanosomiase du chameau ; la raison pour laquelle DNDi enregistre des médicaments destinés à l'Afrique auprès des autorités européennes de règlementation ; ce que l'OMS considère comme facteurs-clés de la réduction marquée des cas de THA et la manière dont l'approche du partenariat public-privé a contribué à ce déclin ; la corrélation entre le nombre de cas de THA et

la qualité des établissements de santé en République centrafricaine ; ainsi que les critères utilisés dans la sélection des pays bénéficiaires du projet NON À LA TRYPANO ! (Trypa-NO!).

Recommandations

1. Notant la fragmentation croissante de l'approche suivie par les partenaires dans leurs efforts visant à contribuer à la lutte contre les T & T, il a été recommandé au CSIRLT et au Bureau de coordination de la PATTEC d'élaborer des cadres de partenariat pluripartites qui serviraient de base pour les contributions des partenaires à la lutte contre les T & T.
2. Notant le cloisonnement apparent entre les recherches sur les T & T et les opérations sur le terrain et les tendances croissantes selon lesquelles certains chercheurs et instituts de recherche assument également le rôle d'exécutants sur le terrain en sus de leurs activités de recherche, il est recommandé que le CSIRLT soit utilisé comme principal organisme centralisateur de l'application des résultats des recherches sur les T & T sur le terrain, qui pourra recommander les institutions les mieux placées pour le déploiement des technologies générées par les travaux de recherche.

REPORT OF PATTEC INITIATIVE AND COUNTRY REPORTS

Moderator: Pamela Olet

Rapporteur: Ndoutamia G. Anaclet

A total of 14 communications were made and related to the topics as varied as the evaluation of the process of the elimination of tsetse and trypanosomiasis in Africa: the challenges and prospects for the future that flow from it, the status of the implementation of the activities of the AU-PATTEC coordination office from 2015 to 2017 and the status of the control of trypanosomiasis in the countries affected by the T&T.

At the end of the different presentations followed by debates and exchanges as rich and varied, the following main points seem to emerge:

1. It was noted with concern that the tsetse fly and trypanosomiasis remains a major constraint to the socio-economic development of the countries affected by the T&T in spite of the laudable efforts;
2. It was noted with concern the disparities that exist in the whole of the countries affected by the T&T in terms of management structures, focal points, priorities, strategies , competence and levels of implementation of activities related to the T&T;

3. It was clear that the availability in resource remains a major problem highlighted in all countries. Many countries need guidance in development and processing of project proposal. It was also noted that many countries have not integrated T&T strategies into national development Plan as a priority for the mobilization of national and regional resources in order to control T&T. countries need to be reminded about the Head of States decision made in Lomé-Togo in the year 2000 to remove T&T from Africa. This should help in prioritization and also, national government to allocate funds for T&T programs.
4. It was emphasized the fact that most of the projects presented by the countries affected by the T&T do not meet the objectives of sustainable development; therefore, it was recognized the need that the projects to take into account the environmental and socio-economic contexts.
5. It was also referred to the need for the AU-PATTEC to develop a new strategic planning based on a critical analysis and a review of its policy and strategies including the development of a plan for the capacity building of the actors of the T&T.
6. It has been recognized the need to develop a regional approach in the development of projects and in the search for funding. This could explain the absence of regional report. To this effect, the Regional Economic Organizations will be especially sought. The AU-PATTEC Coordination PATTEC will then be able to provide technical support to countries affected by the T&T and play the role of facilitator.
7. Concerns have also been raised in relation to the results of research projects which are sometimes implemented by the researchers themselves, instead of transferring them to the sectors of development.
8. There should be report on non-tsetse transmitted trypanosomiasis ;

Recommendations

1. The deliberation of the 34th ISCTRC meeting be presented to the meeting of minister on October 5 and 6 2017 organized by African Union at Addis ababa.
2. The African Union to follow up on the development guide lines to declare T&T free areas.
3. The African Union to encourage government official to sensitize and influence policies on T&T and allocation of resources.

RAPPORT DE L'INITIATIVE PATTEC ET RAPPORTS DES PAYS

Modérateur : Pamela Olet

Rapporteur : Ndoutamia G. Anaclet

Cette session a été dirigée par Pamela Olet assistée par Guelmbaye Ndoutamia Anaclet.

Au total, 14 exposés ont été présentés en rapport avec des sujets variés, notamment l'évaluation du processus d'élimination de la mouche tsé-tsé et de la trypanosomose en Afrique - les défis et les perspectives d'avenir ; la situation de la mise en œuvre des activités du Bureau de coordination de l'UA-PATTEC de 2015 à 2017 ; et l'état du contrôle de la trypanosomose dans les pays affectés par les T & T.

À la fin des différents exposés suivis de débats et d'échanges riches et variés, les principaux points ci-après ont été dégagés :

1. Les participants ont noté avec préoccupation que la mouche tsé-tsé et la trypanosomose demeurent une contrainte majeure au développement socio-économique des pays affectés par les T & T en dépit des efforts louables déployés ;
2. Les participants ont noté avec préoccupation les disparités qui existent dans l'ensemble des pays affectés par les T & T en ce qui concerne les structures de gestion, les points focaux, les priorités, les stratégies, les compétences et les niveaux d'exécution des activités liées aux T & T;
3. Les exposés ont laissé clairement transparaître que la disponibilité des ressources reste un problème majeur souligné par tous les rapports pays. De nombreux pays ont besoin d'orientations dans l'élaboration et le traitement de propositions de projets. Les exposés ont également fait ressortir que de nombreux pays n'ont pas intégré les stratégies de contrôle des T & T dans leur plan de développement national comme priorité pour la mobilisation de ressources nationales et régionales en vue de contrôler les T & T. Il faut rappeler aux pays la décision prise par les chefs d'État à Lomé (Togo) en 2000 pour l'éradication des T & T en Afrique. Ceci devrait aider contribuer à la définition des priorités, et le gouvernement national devrait aussi allouer des fonds aux programmes de lutte contre les T & T.
4. On a souligné le fait que la plupart des projets présentés par les pays affectés par les T & T ne répondent pas aux objectifs de développement durable ; par conséquent, on a reconnu qu'il était nécessaire pour les

projets de prendre en compte les contextes environnementaux et socio-économiques.

5. Les participants ont également évoqué la nécessité pour l'UA-PATTEC d'élaborer un nouveau plan stratégique basé sur une analyse critique et un examen de ses politiques et stratégies, y compris l'élaboration d'un plan de renforcement des capacités des acteurs du domaine T & T.
6. Les participants ont reconnu la nécessité d'élaborer une approche régionale pour la conception des projets et la recherche de fonds. Ceci pourrait expliquer l'absence de rapports régionaux. À cet effet, les organisations économiques régionales seront particulièrement visées. L'Unité de Coordination de l'UA-PATTEC pourra ensuite apporter un soutien technique aux pays affectés par les T & T et jouer le rôle de facilitateur.
7. Des inquiétudes ont également été soulevées par rapport aux résultats des projets de recherche qui sont parfois mis en œuvre par les chercheurs eux-mêmes, au lieu d'être transférés aux secteurs du développement.
8. Il devrait y avoir un rapport sur la trypanosomiase non transmise par la mouche tsé-tsé.

Recommandations

1. Que les travaux de la 34e réunion du CSIRLT soient présentés à la réunion des ministres organisée par l'Union africaine à Addis-Abeba les 5 et 6 octobre 2017 ;
2. Que l'Union africaine fasse le suivi de l'élaboration de lignes directrices concernant la déclaration de zones indemnes de T & T ;
3. Que l'Union africaine encourage les responsables gouvernementaux à mener des actions de sensibilisation et à influencer les politiques sur les T & T et l'allocation des ressources.

REPORT AND RECOMMENATIONS ON HUMAN AFRICAN TRYPANOSOMIASIS

Session 4a. Epidemiology

Moderator: Theophile Josenando

Rapporteur: Jose Ramon Franco

It was started by a Key note presentation given by J. R. Franco entitled Capitalizing on the progress made towards elimination of HAT – the way forward. It was remarked that the outstanding decreasing trend in the number of HAT cases observed from 2000 to 2016, due to different factors:

- Sustained case-finding efforts
- Treatment of all cases detected
- Work done by NSSCPs
- Support of partners
- Coordination and guidance from WHO

The benchmarked line established in order to monitor the progress towards elimination as a public health problem by 2020 is on track and even surpassed. The real challenge will be to sustain the efforts after 2020, with the goal of elimination as zero transmission by 2030. If we want to reach this target, we will have to adapt the strategies and technologies. The main challenges identified on the way for elimination are:

- Peaceful context and social stability
- Integration of HAT in the general health services
- Ownership and commitment of national authorities
- Coordination between stakeholders
- Access to treatment is guaranteed but it is needed to ensure access to screening and diagnosis tools for the population at risk.
- The funding available is far from being sufficient

Kassi N'Djetchi et al. have presented his work on trypanosomes species circulating in domestic animals in 2 HAT foci in Cote d'Ivoire (Sinfra and Bonon). Pigs and cattle have been identified as potential reservoirs of TBG after using parasitological techniques, molecular biology (PCR) and trypanolysis (TL). Pigs and cattle show high level of infection but it was not

possible to precise if it was T. b. gambiense because lack of concordance between molecular tests (not sensitive enough) and trypanolysis (positive trypanolysis for Li.Tat 1.3 and 1.5). This discordance in the results did not allow to conclude. Nevertheless it was decided to adapt control strategies by vector control using tiny targets and treatment of pigs, aiming at a positive impact on both HAT and AAT.

Dama et al have described the first autochthonous HAT case diagnosed in Burkina Faso over the two past decades and the risk of the re-emergence of the disease. Burkina had an important burden of HAT in the 30's to 60's, mainly in the South Western part of the country, but due to control efforts and climate change not in favour of tsetse, huge decrease in the number of cases was experienced. Last native case of HAT was detected in 1993 in Burkina Faso. Since then, there have been sporadic cases but there were considered as imported cases in workers who displaced to endemic zones in Cote d'Ivoire. Tsetse is still present in the country. In 2015 a patient was presented in Banfora and was diagnosed of HAT finding parasites in CSF after having a positive RDT, trypanolysis positive. Trypanosoma was found in CSF. The molecular techniques have not allowed to confirm T.b. gambiense as TgsGP has been negative but TL positive 1.3, 15 and 1.6. It has been demonstrated the risk of re-emergence, strengthening passive surveillance. A reactive screening was planned in the area and 4214 people tested but no other case was detected. It is needed to strengthen passive surveillance

Bukachi et al. have worked tracing the source of infection of gambiense HAT in a study of 8 recent cases (2015-2016) in Uganda Data about the cases was collected through a questionnaire. Cases were diagnosed after 2-12 months presenting symptoms. As conclusions it is needed to reduce steps for HAT diagnostic confirmation and increase the index of suspicion of health workers. This work is intended to identify potential areas of transmission and target control measures to those areas.

L. Grout et al have presented the activities to transfer the technology of the Atlas of HAT to endemic countries to use it for analysing the data, to evaluate the active screening activities and to plan new active screening activities, showing the utility of this tool for monitoring, evaluating and planning. 3 sessions of training have been organized and equipment and software has been provided to 10 gambiense HAT endemic countries. HAT Atlas is used since 2016 during the annual meeting for planning HAT control activities in DRC

In the discussion time, it was raised the aspect of the robustness of data of HAT for elimination considering the low coverage of active screening activities (e.g. around 30% in some areas of DRC), so the coverage should be improved in order to estimate better the burden of disease and then rightly monitor the trends. That's true but there are elements to be considered as the improvement of the coverage mainly in passive. It has to be also considered that may be there is an under-estimation of this coverage:

- Villages may be visited yearly and the people screened every year may not be the same passive screening is not considered in this calculation. So if we consider people covered in larger periods of time, these figures could improve considerably.
- More people has nowadays access to health facilities capable of detecting HAT, as the network and quality has been increased, and this is not considered in the figures of coverage.

Said that, yes it is important to improve the coverage, by focusing first in the population at high and very high risk.

Also the displacement of people and consecutive presence of refugees can hampered the elimination of the disease. This si true and as referred social stability and peace is key in the control and elimination of HAT. Nevertheless there are ways to approach HAT in refugees' settlements.

Kassi N'Djetchi referred that the tropism observed in flies towards pigs is probably due to the mobility of pigs which visited more areas where contact with vector is increased.

Session 4b: Diagnostic and treatment

Moderateur : C. Wamboga

Rapporteur: Lise Grout

Silla Semballa was not able to give his presentation on the confirmation of antibodies against L-Tryptophane epitope in HAT serological diagnosis.

Simon Kayembe presented the prospective evaluation of a RDT for gHAT develop using recombinant antigens in the DRC. Current RDTs for HAT (RDT1) require the production of native antigens, which is challenging. A non-inferiority study was performed in order to assess the non-inferiority

of a new RDT (RDT2, using recombinant antigens) compared with RDT1, in terms of sensitivity and specificity. RDT2 was also compared to CATT. The study was conducted in 10 fixed health facilities and 5 mobile teams in DRC. Any person positive to any of the serological tests was going through parasitology confirmation. The laboratory tests were blinded (both serology and parasitology). 260 HAT cases and 56959 controls were included and tested. The non-inferiority targets of RDT2 vs RDT1 were met both for sensitivity and specificity (overall). Sensitivity was higher in passive screening; combining RDT1 with RDT2 resulted in a higher sensitivity both in active and passive screening. Specificity was lower in passive screening and RDT2 was inferior to RDT1 in terms of specificity in passive screening. The RDT2 will be commercialized from 12st September 2017. FIND is considering the development of a 3rd generation RDT with more antigens in order to achieve a higher sensitivity. Finally, several screening tests could be used in parallel to enhance sensitivity. Cost-effectiveness analyses will help determine the best diagnostic algorithm, which may depend on the actual setting (e.g. prevalence, active/passive).

Then Oumou Camara presented the introduction of RDTs as screening tool for HAT in Guinea. Guinea has the highest burden of HAT in West-Africa. RDTs were introduced in 90 health facilities in early 2014 in order to strengthen the passive surveillance. Due to the Ebola crisis, passive detection stopped, and new strategies had to be introduced such as targeted screening and door-to-door strategy in islands and hard-to-reach areas. Specificity of the RDTs was high (>94% in all settings). The Positive Predictive Value (PPV) varied significantly (from 8.7% to 66%) depending on the screening strategy and the prevalence. The higher the prevalence, the higher the PPV. RDTs could be a useful tool for door-to-door screening in high endemicity areas like mangrove islands.

The session 4c closed at 4:40 pm in order to allow for a break before the WHO/FIND symposium. There was no question for the first two presenters.

On 13th September, Veerle Lejon opened the session 4c at 8:15 am by presenting the DiTECT-HAT project. She pointed out that some challenges remain for HAT elimination: i) the integration of diagnosis and care into the general health system, ii) monitoring of eliminated foci and iii) development of safe and efficacious drugs. The needs identified by DiTECT-HAT to tackle those challenges are i) diagnostic tests & algorithms adapted to passive case detection; ii) early detection of outbreaks but avoiding unnecessary alarms and iii) accurate, early and non-invasive test of cure. The expected results of the DiTECT-HAT project are i) cost-effective diagnostic algorithms for improved case management and test-and-treat scenarios without parasitological

confirmation if possible, ii) appropriate threshold to trigger active case finding and avoid re-emergence of HAT, without false alarm and iii) an earlier treatment outcome assessment tool to speed up drug development and improve routine management of relapses. So far, on the passive surveillance project, SOPs and electronic CRF have been developed, trainings have been conducted and the projects have started in Guinea and Côte d'Ivoire. Inclusions should start in RDC and the 2nd generation RDT should be included in the study. On the early test-of-cure project, SOPs have been developed and activities have started in 4 out of 5 sites.

Philippe Büsher then presented the digital recording of DiTECT-HAT study participant data. In the context of integration of HAT control into the general health system, there is a need of improved data management and quality control. An application has been developed to capture demographic, clinical and diagnostic data on study participants with a smartphone or tablet, transferring data to a central database for analysis and allow for remote control of diagnostic test results. The challenges for developing this kind of application were numerous: avoid commercial software licenses, applicable to most microscope types, applicable on Android smartphones or tablets, capturing both pictures and movies, safe data transfer, low power consumption.... Philippe Büsher then walk us through the different steps of entering data in the application. After log in, you start entering data on the patient: patient general information, clinical symptoms, results on the serological test (a picture of the 3 different tests by patient has to be taken), results of the parasitological test (if one of the serological tests is positive). If positive, a 4-second video of the trypanosome has to be recorded by connecting a camera to the microscope. The data are then sent to the server as soon as you have a good internet connection. That may fail. But you can also transfer the data to a SD card in order to send the data. The data are then available on the server for analysis.

Mamady Camara presented the detection of trypanosomes in skin biopsies, on behalf of Mariame Camara. HAT is close to elimination in many areas in Western Africa. The presence of reservoirs may explain the transmission patterns. But some HAT foci are persistent, despite lacking an animal reservoir. Recent studies in mice have suggested an overlooked anatomical reservoir of T.g. gambiense in the skin. The objective of this study was to determine whether skin trypanosomes could also be found in humans. Skin biopsies were taken from 55 individuals, including 28 parasitologically confirmed HAT cases and 8 unconfirmed seropositive individuals. Dermatological signs (such as dermatitis and pruritus) were more frequently reported by HAT cases. After treatment, the pruritus was significantly lower or disappeared in 100% of the stage 2 patients. Skin biopsies were found positive for trypanosomes for 16 HAT cases and 6 seropositive individuals. Skin-dwelling trypanosomes in aparasitemic patients and especially in latent infection cases are likely to

represent the missing link responsible for the maintenance of the parasite transmission in Guinea. There is a need for further studies in order to confirm these findings.

Nick Van Reet continued with the presentation of the novel PCR primers for improved detection of Trypanozoon satellite DNA in human blood. Parasites of the subgenus Trypanozoon contain specific satellite DNA sequences of 177 base pairs. But surprisingly, these Trypanosoma brucei repeat (TBR) sequences are often targeted in PCR. But this exact 177bp sequence is not found in the Tbg genome databases. Instead, the original sequence appears to be a mixture of two main groups or repeats that are either 177bp or 176bp long. During prevalence studies of Trypanozoon parasites, scientists were complaining about the low sensitivity of the PCR. Based on this new sequence information, they developed several novel TBR-primer sets for amplification of both repeats. Initial results show that these novel primer sets are able to detect <15 Tbr cells/mL and <30 Tbg cells/mL in spilked human blood extracts. In clinical samples, novel Tbr-primers give high sensitivity, but apperent low specificity. Primers will be converted to real-time format.

The two following presentations were about LAMP test. Boniface Namangala presented the rapid detection of human-infective trypanosomes in clinical specimens from Zambia's river valleys using LAMP. As early detection of HAT is key to its successful management, the presenter stressed the need for a cheaper, quicker and yet sensitive & specific diagnostic technique. The objective of the study was to evaluate the potential use of the Loop-mediated isothermal amplification (LAMP) test as a rapid diagnostic tool of human-infective trypanosomes in clinical specimens from Zambia's river valleys. Blood and cerebrospinal fluid was sampled from human, blood was taken from domestic animals and tsetse were trapped in former HAT foci. Two primers were used in this study, one targeting RIME expressed by Trypanozoon and one targeting SRA which is more specific to T.b. rhodesiense. The LAMP was slightly modified to cope with field conditions (Dry LAMP). Various animal-infective trypanosome species were detected in parasitaemic and aparasitaemic animals as well as in tsetse flies. Moreover, LAMP system was able to distinguish the Tbr from very closely related trypanosomes species and was detected in patient blood and cerebral spinal fluid. Tbr was also detected in domestic animals and tsetse flies, suggesting their possible role in HAT epidemiology. This study has raised the HAT sensitization among local health personnel & residences, which helped improving the reporting of suspected HAT cases and therefore saved lives. A continuous surveillance of Tbr in humans, domestic, wildlife reservoir and tsetse vectors is needed in Zambia. The field-friendly Dry LAMP is a potential tool for HAT diagnosis, staging and may be useful for making therapeutic decisions.

As a continuation, Kyoko Hayashida presented the development and evaluation of a novel dry LAMP kit for rapid diagnosis of HAT. LAMP test still showed some challenges: complicated DNA extraction step, need for a cold chain for reagents, and expensive reagent. The objective of this project was to design a more simple, stable, and cost-effective LAMP system. Firstly, a Colori Fluorometric Indicator (CFI) which is cheaper and stable room temperature was developed. Secondly, all the reagents were dried in one tube using Trehalose and Glycerol as cryoprotectant. This dry-LAMP was tested for thermostability (3 days at 45°) and appeared therefore more convenient for transportation. Third, thanks to the new CFI, sample preparation was simplified as it can be used directly on blood. For detection, a cheap hand-made buttery driven LED detector was made. After testing a 1st prototype dry-LAMP in Zambia under field condition, a stable/mass production of Dry-LAMP reagents with ink-jet printer was developed. Quality control of the machine-made dry-LAMP was performed. No difference was observed between conventional and machine-made dry-LAMP in terms of detection rate. Reaction time was set as 45 min for RIME-LAMP and 30 min for SRA-LAMP. Finally, they tested whether storage temperature condition affect the quality of dry-LAMP. As reaction time become longer for sample stored at room temperature, they recommend to long-term storage of sample to be at 4°. With these improvement, on-site diagnosis of HAT in the field become reality as the whole procedure is very simple, cheap and sensitive results are available within one hour. Dry-LAMP is now in validation stage in local clinics here in Zambia.

Nick Van Reet came for a second presentation on the diversity of aquaglyceroporin genes (TbAQP) in Trypanozoon and their relation to melarsoprol and pentamidine cross-resistance (MPXR). MPXR is linked to the deletion or the mutations within the AQP2 gene, I.e. the chimerisation of AQP2 by incorporation of different proportions of AQP3 gene into AQP2 coding sequence. Indeed, T.b. gambiense strains that have only AQP2/3 chimeras and no wild-type AQP2 gene displays various levels of MPXR. Tbg strains that contain AQP2/3 chimeras but also wild-type AQP2 gene remain melarsoprol and pentamidine sensitive. Resistance against diminazene, which closely resembles pentamidine, has no relation to AQP2 mutations, but with AT1 receptor. Moreover, some T. evansi and T. equiperdum strains, that have never been exposed to pentamidine or melarsoprol, also carry AQP2/3 chimeras but are not resistant to pentamidine or melarsoprol.

Finally, Digas Ngolo presented the baseline clinical assesment for g-HAT patients in DRC and CAR during DNDi clinical trails, on behalf Olaf Valverde. Three clinical studies have been completed by DNDi and one is ongoing. In total, 749 patients were included in the 3 completed clinical trials. Study population includes all HAT stages but is not representative of all HAT cases because of exclusion criteria (too seriously ill or malnourished, pregnant

and breastfeeding women, children < 6 years of age,…). Headache was the symptoms most commonly reported at inclusion (67%), followed by cervical adenopathy (43%), impotence or amenorrhoea (1/3 of adults), neurologic symptoms (more frequent in 2nd stage) and sleepiness (11% in 1st stage patients). There may have been some confounding co-infection as 36% of the HAT caess were co-infected with malaria which causes fever and headache and 8% diagnosed with scabies or other skin condition which may cause pruritus. Characteristic signs and symptoms of Sleeping Sickness manifest mainly in advanced stage. As recommendations, cervical adenopathies should always be explored and a thorough neurological examination can help orientate diagnosis especially in advanced stage HAT.

The six following questions were asked to the presenters.

1. ***To Nick, he mentioned resistance in Kasai (DRC). Is there any factors in favour of the resistance in this province?***

There were a lot of people already in late stage 2. High treatment failure can probably be explained by the mutation but may also be also because the patients were presenting in a late stage.

The drug may have difficulties to kill the parasite in this late stage.

2. ***To Veerle, how could you sustain the technicians on site because we know the high turn-over, even more if there is no "motivation"? Will we have to maintain this "motivation" at the end of the study?***

The project has started only 1 month ago so it is too early to answer on the turn-over rate.

The motivation is decided country by country by the Ministry of health.

3. ***To Veerle, there are several challenges in the field: decrease in the prevalence, low rate of use of the health facilities, symptoms frustre at the beginning so that people do not seek treatment. How will your project be useful in this context?***

We will not change this reality. What we hope is to change the PPV by finding combination of tests that will hopefully increase it. If at one point there is a re-emergence, we also aim at having a combination of diagnostic tests that will be available for mobile team doing reactive screening.

4. ***To Philippe, with the connectivity challenges, are the pictures and videos not too heavy for internet transfer?***

This may indeed be a challenge. But the video itself is only 1MB, so not so heavy. The connection is also more or less stable, and the data and the pictures/videos are also sent through 2 different channels. For the moment the main problem is the training of the people for the use of the application.

5. ***To Kyoko, how did you avoid contamination with the simplication of the LAMP test?***

As you are using very specific primers, there is no such a risk of sample contamination.

6. ***To Camara, where were performed the skin biopsy?***

We received the support from dermatologists in order to perform imagery and skin biopsies.

Session 4c. Control and surveillance strategies & Vector Control

Moderator: Mamadou Camara

Rapporteur: Jose Ramon Franco

Priotto addressed the issue of HAT integrated passive surveillance for the documentation of its elimination. This was the case of countries were formerly presented HAT cases but after several years, no cases are declared despite active screening activities have been running. This surveillance system addressed to assess elimination of Hat has to be sustainable and therefore integrated in the health system. It has to be complemented by reactive active screening if cases are detected. It is based in the introduction of RDTs in selected health facilities (sentinel sites) and the subsequent parasitological research for confirmation or referral of samples for study with trypanolysis. Reporting system has been established. Supervision of the system is critical. Up to now 113 sites are working in 15 countries and just 1 case has been detected in Burkina Faso.

Mumbo presented the rolling out the communication strategy in the frame of the intensified sleeping sickness elimination programme in South Sudan using an integrated strategy. A baseline KAP survey was performed in Yei County, taking into account its multicultural composition which includes main groups of Central Equatoria. This survey show that population has knowledge about HAT but with some misinformation mainly related to transmission and risk of the disease. This survey revealed a stigma of affected people. Majority

of the people (90%) look for care at stablished health facilities. Posters and figures were the communication material preferred. According to the results of the survey, IEC material was developed (flip charts, brochures, pamphlets, radio jingles and drama), mainly in English but facilitators (community health workers and other health staff and community leaders) can translate it into local languages. IEC were tested and they are currently in use.

Priotto presented an update of the WHO network for Hat elimination as key element for the elimination of the disease. The importance of coordination of partners for elimination was highlighted. The WHO Network for Hat elimination was reviewed. It is based in the group for rhodesiense and gambiense network, which includes the stakeholder meeting, the scientific consultative group, the country coordination meetings and different implementation coordination groups.

Selby presented the tsetse control operations as an element of chronic HAT reduction in Yasa Bonga Active screening has been performed in the area for several years being effective in reduced the number of cases. In 2015 tiny targets were placed in a reduced area along the rivers, that was expanded after one year to North and then to the east. In total, in July 2017, 11,311 tiny targets had been placed. The tsetse population has been reduced by more than 80% in total which has contributed to reduce risk of transmission. Early results indicate that combination of active screening plus vector control is most effective to reduce the burden of HAT. Investigating spatial distribution of HAT in villages has shown that HAT and tsetse are not everywhere in the area, so it is possible to focus vector control in areas around the villages where vector control contact is more probable.

Rock explained the dynamics of gambiense sleeping sickness through mathematical modelling as method useful to quantify success of past HAT interventions and to show how transmission and reporting would look like approaching 20230.Modelling is a flexible framework, depending on data reliance. It is useful to test hypothesis and to make descriptions on "what-If" scenarios to assess progress towards goals of elimination. It can be used to measuring underreporting and to forecast impact of current strategies on transmission. Assumptions are needed on modelling and in the case of HAT it was assumed that some people are bitten more by tsetse, and that animals might play a role in transmission. Examples of this use are the works done In Mosango and Yasa Bonga in Bandundu (2000-2012) and Mandoul in Chad (2000-2013). It was estimated that current strategies of cases finding have a success in the reduction of the disease of 53 % of transmission in Mosango and Bonga Yasa and 67-75% reduction in Mandoul. The model indicates that Mosango and Bonga Yasa will not reach the 2030 goal and it was considered

that in some regions missed high-risk groups which are thought to drive transmission are missed by active case finding activities. Model predictions considered that even moderate tsetse population reduction could rapidly reduce transmission. Future work includes more realistic future strategy simulation of smaller spatial scale and cost estimations

Mansinsa described the transmission of sleeping sickness in the health zone of Bonga Yasa. The places of contact vector human have been investigated based in the usual activities of the population (related to agricultural activities and fishing). Glossinas have been found in the villages and also in the small spots remaining of primary forest. The first one can be related to peridomestic transmission and the second to reinvasion of areas that have been previously controlled.

Session 4d

Moderator: Alain Mpanya.

Enhanced Screening and Diagnosis of gambiense Human African Trypanosomiasis in North-western Uganda - Moving Towards Elimination

Presented by Charles Wamboga, Ministry of Health, Kampala, Uganda. In Uganda the gambiense human African trypanosomiasis burden has been declining, from 198 cases in 2008, to only 4 in 2016. One of the key elements of the strategy leading to this decline was the CATT serology. In 7 districts of North-western Uganda an expansion of passive screening has been implemented since 2013, including 212 health facilities, which were reduced to 125 facilities after 2014. The screening strategy is based on rapid diagnostic tests (RDTs) to screen patients featuring clinical suspicion of HAT, followed by parasitological confirmation at strategically located microscopy centres. For patients with negative parasitology, blood samples are tested by loop-mediated isothermal amplification (LAMP), which if positive leads to re-testing by parasitology. A mHealth approach to electronic data capture has been implemented using an IT application, which improves reporting, management of the project, and serves to remind patients of their appointments via SMS.

This network of peripheral sites has reduced the distance that a sick person must travel to be screened to a median of 2.5km. The median distance to microscopy centres is 12.5 km.

RDTs were performed on 27,137 clinical suspects, with 708 positives (2.6%), of whom 76% reached the microscopy centres. Confirmed HAT cases were

19, of whom 2 came from peripheral sites and 2 more from private clinics.

A targeted door-to-door strategy for sleeping sickness detection in low-prevalence settings in Côte d'Ivoire

First author: Mathurin Koffi. Presented by Vincent Jamonneau

In 2012, we carried out a targeted door-to-door (TDD) survey focused on the immediate area around former HAT patients in the HAT focus of Bonon and compared the results to those obtained during classical active mass screening (AMS).

The TDD survey examined 1058 people who were neighboring the 72 old cases localized. Seven persons were Trypanolysis positive, and 4 were confirmed as HAT cases. Also, the 72 old cases could be controlled (no relapses were found).

The TDD detected significantly more HAT cases than the AMS. Cost was comparable. These results suggest that the TDD is an efficient and useful strategy in low-prevalence settings where very localized transmission cycles may persist and, in combination with passive surveillance, could help in eliminating HAT.

Inputs from new strategies to contribute to eliminating HAT: Case of Mandoul focus, Chad

Presenter: Mallaye Peka

Chad has five foci, with an average of at least 50 new cases reported each year since 2014. Since 2015, new approaches to HAT control have been introduced in Mandoul focus:

- extension of passive screening to health facilities in Bodo district;
- strengthening active screening through a mobile motorcycle team using rapid diagnostic tests (RDTs), with a referral system for parasitological confirmation;
- vector control using tiny impregnated screens.

In 2015-2016, 120 new cases were detected (67 in 2015 and 53 in 2016), including 72 cases (60%) in Mandoul focus. Of these 72 cases, 40 (56%) were detected through passive screening by the 10 health facilities that integrated

the use of RDTs. In previous years (2013-2014) health facilities had diagnosed 101 cases (37%) through passive screening. In 2015-2016, active screening by the mobile motorbike team detected 10 cases (14%) in addition to the 32 new cases diagnosed through active screening by CATTwb by the mobile team in vehicles; i.e. 44% of the total number of notified cases.

Strategies integrating RDTs contribute to improving detection of HAT cases. Their use in other HAT foci should be sustained.

Intensive passive surveillance for human African trypanosomiasis in Delta state, Nigeria

Enwezor, F.N.C

The last confirmed case of HAT in Nigeria was reported in 2013. In 2014, NITR, FIND and the Ministry of Health of Nigeria initiated a collaboration to implement passive screening using HAT-RDTs, LED-fluorescence microscopy and LAMP integrated into the primary healthcare system. Fifty- one health facilities were included. In 2016, the number of facilities for confirmatory testing were increased from four (4) to 25, reducing the distance that RDT positive-suspects have to travel for confirmation. By March 2017, 7,310 patients had been screened with HAT-RDTs and 211 (2.89%) were positive, of which sixty-five presented for confirmatory testing. No HAT case has so far been identified. The strategy has now been reviewed to a more sustainable, targeted passive surveillance in 19 health facilities. More synergy among partners is needed to support elimination of the disease in Nigeria.

Geographic distribution of Human African Trypanosomiasis cases in the Democratic Republic of Congo from 2011 to 2015: analysis of HAT Atlas data.

Shampa Chansy

The Democratic Republic of Congo (DRC) has the largest number of cases of human African trypanosomiasis (HAT) worldwide, with more than 80% of cases reported to the World Health Organization. HAT Atlas is a major asset for improved knowledge of the distribution of HAT patients, georeferenced at the village level.

From 2011 to 2015, 22,764 cases of HAT were reported by the DRC, and various maps developed show the cumulated situation of cases and their

distribution by transmission zones.

Endemic health areas decreased from 252 in 2011 to 194 in 2015 out of a total of 516 health areas in DRC. 4105 villages reported at least 1 new case (NC) of HAT. 567 villages notified first stage cases.

Analysis of Atlas data enabled streamlined planning of active screening activities in 2016 and 2017. It also guided the selection of 15 sentinel sites in Mongala province, the selection of sites for clinical trials, and sites for vector control project (impregnated screens).

The establishment of this database and identification of HAT transmission areas enable the national program to better plan control and surveillance activities.

Integration of Human African Trypanosomiasis into basic Health Services - a scoping review

Mulenga P

We undertook this scoping review of documentation on integrating HAT control. The review was conducted on PubMed from 1977 to 2017 and on grey literature documents. 35 documents were selected. The reasons for integrating HAT were either epidemiological, efficiency, organization of health care, or for sustaining control and elimination of HAT. Three categories of factors influenced the implementation and maintenance of HAT integration: factors related to the clinical course of HAT, factors related to the organization of health services and users, and factors related to diagnostic and therapeutic tools. Some positive results from the experiments were reported and several recommendations were made in the documents.

Feasibility of eliminating HAT through increased screening coverage using innovative methods in the Democratic Republic of Congo (DRC).

Mpanya Alain

Introduction

In two health areas in DRC, Yasa-Bonga and Mosongo, the "TRYPELIM" project has been implemented (2016-2018) to assess the feasibility of eliminating HAT by increasing screening coverage with innovative approaches.

In order to plan active screening, maps were produced with endemic villages for the last 5 years plus villages without cases located within a 5km radius. Door-to-door screening was conducted by mini-teams and mass campaigns by the large classic team. Rapid diagnostic tests were also introduced in health centers. Data collection is done with a mobile application that feeds the decision-making system. The screened population rose from 83,808 to 196,622 in the first year of the project. 62% were screened by mini-teams. 3,406 serological suspects were identified, including 2,920 (86%) by mini-teams. 50 new cases were diagnosed including 13 (26%) by mini-teams. 4 cases were from villages considered non-endemic. This approach has improved coverage.

Ensuring refugees are not left behind in sleeping sickness elimination: governance lessons from Uganda

Jennifer Palmer

It is key to consider if displaced populations and host nationals are equally able to access the same healthcare resources. Comparing use of RDTs between host vs refugee populations can be a marker for differential 'access'.

There are added communication complexities when working with forced migrants. Difficulties communicating through different languages & cultures made screening for an atypical disease based on symptoms challenging.

Humanitarian agencies are decreasingly involved in HAT, leaving government programmes & partnerships an increasing responsibility to ensure forcibly-displaced populations are not left behind. Elimination surveillance strategies are dependent on imperfect technologies which are controlled by people. We must consider social behaviours when interpreting surveillance data.

RAPPORT ET RECOMMENDATIONS SUR LA TRYPANOSOMIASE HUMAINE AFRICAINE

Session 4a. Epidémiologie

Modérateur : Theophile Josenando

Rapporteur : Jose Ramon Franco

Au début de la session, J. R. Franco a présenté un exposé thématique intitulé « Exploiter les progrès accomplis sur le chemin de l'élimination de la THA – perspectives d'avenir ». L'orateur a fait remarquer que la forte tendance à la baisse du nombre de cas de THA observée de 2000 à 2016, est attribuable à différents facteurs, notamment :

- les efforts soutenus de dépistage de cas ;
- le traitement de tous les cas détectés ;
- les travaux effectués par les programmes nationaux de lutte contre la maladie du sommeil ;
- le soutien des partenaires ;
- la coordination et les conseils de l'OMS.

Les repères définis pour le suivi des progrès atteints vis-à-vis de l'élimination de la THA en tant que problème de santé publique d'ici 2020 sont dans la bonne voie, voire dépassés. Le défi réel sera de soutenir les efforts après 2020, avec l'objectif d'élimination totale d'ici 2030. Si nous voulons atteindre cet objectif, nous devrons adapter les stratégies et les technologies. Les principaux enjeux identifiés par rapport à l'élimination sont :

- le contexte pacifique et la stabilité sociale ;
- l'intégration de la THA dans les services de santé généraux ;
- l'appropriation et l'engagement des autorités nationales ;
- la coordination entre les parties prenantes ;
- l'accès au traitement est garanti, mais il est nécessaire d'assurer l'accès aux outils de dépistage et de diagnostic pour la population à risque ;
- le financement disponible est loin d'être suffisant.

Kassi N'Djetchi et al ont présenté leurs travaux sur les espèces de trypanosomes circulant parmi les animaux domestiques dans 2 foyers de THA en Côte d'Ivoire (Sinfra et Bonon). Les porcs et les bovins ont été identifiés

comme des réservoirs potentiels de TBG après utilisation de techniques parasitologiques, la biologie moléculaire (PCR) et la trypanolyse (TL). On a détecté un taux d'infection élevé chez les porcs et les bovins, mais on n'a pas pu déterminer avec précision s'il s'agissait d'une infection à T. b. gambiense en raison du manque de concordance entre les tests moléculaires (pas suffisamment sensibles) et la trypanolyse (positive pour Li.Tat 1.3 et 1.5). Cette discordance entre les résultats ne nous a pas permis de parvenir à une conclusion. Néanmoins, il a été décidé d'adapter les stratégies de lutte antivectorielle en utilisant des cibles minuscules et le traitement des porcs visant un impact positif tant à la fois sur la THA et la TAA.

Dama et al ont décrit le premier cas autochtone de THA diagnostiqué au Burkina faso au cours des deux dernières décennies et le risque de réémergence de la maladie. Le Burkina a eu une importante charge de THA dans les années 30 à 60, principalement dans la partie sud-ouest du pays, mais en raison des efforts de contrôle et du changement climatique non propice aux mouches tsé-tsé, le pays a enregistré une forte diminution de cas. Au Burkina Faso, les derniers cas autochtones de THA avaient été détectés en 1993. Depuis lors, des cas sporadiques ont été identifiés, mais ils étaient considérés comme des cas importés à la suite du mouvement des travailleurs vers les zones endémiques en Côte d'ivoire. Les mouches tsé-tsé sont toujours présentes dans le pays. En 2015, un patient a été présenté à Banfora et montré un résultat positif pour la THA suite à la détection de parasites dans le LCR après un test de diagnostic rapide (TDR) positif, une trypanolyse positive. Trypanosoma a été détecté dans le LCR. Les techniques moléculaires n'ont pas permis de confirmer T.b. gambiense car TgsGP était négatif mais TL positif 1.3, 15 et 1.6. Un risque de réémergence a été révélé ; ainsi le renforcement de la surveillance passive est nécessaire. Un dépistage réactif a été effectué dans la région, et 4214 personnes ont été examinées, mais aucun cas n'a été détecté. Il est nécessaire de renforcer la surveillance passive.

Bukachi et al ont travaillé à l'identification de la source d'infection de la THA à gambiense dans le cadre d'une étude de 8 cas récents (2015-2016) en Ouganda. Les données sur les cas ont été collectées au moyen d'un questionnaire. Les cas ont été diagnostiqués après 2-12 mois d'observation de symptômes. Comme conclusion, il est nécessaire de réduire les étapes de confirmation du diagnostic de la THA et relever l'indice de suspicion des travailleurs de la santé. Ce travail vise à identifier les zones potentielles de transmission et à cibler les mesures de contrôle dans ces zones.

L. Grout et al ont présenté les activités visant à transférer la technologie de l'Atlas de la THA aux pays endémiques pour utilisation dans l'analyse des données, évaluer les activités de dépistage actif et planifier de nouvelles

activités de dépistage actif, montrer l'utilité de cet outil pour le suivi, l'évaluation et la planification. Trois (3) sessions de formation ont été organisées, et le matériel et les logiciels ont été fournis à 10 pays endémiques pour la THA à gambiense. L'atlas de la THA est utilisé depuis 2016 pendant la réunion annuelle de planification des activités de contrôle de la THA en RDC.

Au moment des discussions, les participants ont fait mention de l'aspect robustesse des données de la THA pour élimination compte tenu de la faible couverture des activités de dépistage actif (par exemple près de 30% dans certaines régions de la RDC). Ainsi, la couverture devrait être élargie pour une meilleure estimation de la charge de la maladie et un suivi approprié de son évolution. Ceci est vrai, mais il y a des éléments à prendre en considération car l'amélioration de la couverture porte principalement sur la surveillance passive. Il faut aussi considérer le fait qu'il peut y avoir une sous-estimation de cette couverture :

- Les villages peuvent être visités chaque année et les personnes ainsi examinées peuvent ne pas être les mêmes ; le dépistage passif n'est pas considéré dans ce calcul. Par conséquent, si nous considérons les personnes couvertes pendant de longues périodes de temps, ces taux pourraient s'améliorer considérablement.
- Un plus grand nombre de personnes a actuellement accès aux établissements de santé capables de détecter la THA, car le réseau a été agrandi et la qualité améliorée, et ceci n'est pas pris en compte dans les taux de couverture.

Ceci dit, il est effectivement important d'améliorer les taux de couverture, en se concentrant d'abord sur la population à haut risque et à très haut risque.

De plus, le déplacement des populations et la présence consécutive de réfugiés peuvent constituer une entrave à l'élimination de la maladie. Ceci est vrai, et comme on l'a déjà mentionné, la stabilité sociale et la paix sont essentielles dans le contrôle et l'élimination de la THA. Néanmoins, il existe des moyens d'aborder la THA dans les camps de réfugiés.

Kassi N'Djetchi a indiqué que le tropisme observé chez les mouches en direction des porcs est probablement dû à la mobilité des porcs qui visitent des zones où le contact avec le vecteur est plus prononcé.

Session 4b: Diagnostic et traitement

Modérateur : C. Wamboga

Rapporteur : Lise Grout

Silla Semballa n'a pas été en mesure de présenter son exposé sur la confirmation des anticorps contre l'épitope L-Tryptophane dans le diagnostic sérologique de la THA.

Simon Kayembe a présenté un exposé sur l'évaluation prospective d'un test de diagnostic rapide (TDR) de la THA à gambiense (gHAT) développé en utilisant des antigènes recombinants en RDC. Les TDR actuellement utilisés pour la THA (RDT1) exigent la production d'antigènes indigènes, une tâche qui est difficile. Une étude de non-infériorité a été effectuée dans le but d'évaluer la non-infériorité d'un nouveau TDR (RDT2 en utilisant des antigènes recombinants) par rapport au RDT1, en termes de sensibilité et de spécificité. Le RDT2 a également été comparé avec CATT. L'étude a été réalisée dans 10 établissements de santé fixes et 5 équipes mobiles en RDC. Toute personne positive pour l'un des tests sérologiques a été soumise à un test de confirmation par parasitologie. Les tests de laboratoire ont été effectués en aveugle (sérologie et parasitologie). 260 cas de THA et 56959 témoins ont été inclus et examinés. Les cibles de non-infériorité de RDT2 par rapport à RDT1 ont été atteintes à la fois pour la sensibilité et la spécificité (globalement). La sensibilité était plus élevée dans le dépistage passif ; la combinaison de RDT1 et RDT2 a entraîné une plus grande sensibilité à la fois dans le dépistage actif et passif. La spécificité était plus faible dans le dépistage passif et RDT2 était inférieur à RDT1 en termes de spécificité dans le dépistage passif. Le RDT2 sera commercialisé à partir du 12 septembre 2017. FIND envisage de mettre au point un TDR de 3ème génération comportant plus d'antigènes afin d'obtenir une sensibilité plus élevée. Enfin, plusieurs tests de dépistage pourraient être utilisés en parallèle pour améliorer la sensibilité. Les analyses coût-efficacité contribueront à déterminer le meilleur algorithme de diagnostic, lequel peut dépendre du contexte réel (par exemple : prévalence, actif / passif).

Ensuite, Oumou Camara a présenté l'introduction des TDR comme outil de dépistage de la THA en Guinée. La Guinée a la plus lourde charge de THA en Afrique de l'Ouest. Les TDR ont été introduits dans 90 établissements de santé au début de 2014 afin de renforcer la surveillance passive. En raison de la crise d'Ebola, la détection passive a été arrêtée et de nouvelles stratégies ont dû être introduites, notamment le dépistage ciblé et la stratégie porte-à-porte dans les îles et les zones difficiles à atteindre. La spécificité des TDR était élevée (> 94% dans tous les contextes). La valeur prédictive positive (PPV : Positive Predictive Value) variait significativement (de 8,7% à 66%)

en fonction de la stratégie de dépistage et de la prévalence. Plus la prévalence était élevée, plus la PPV était élevée. Les TDR pourraient être un outil utile pour le dépistage porte-à-porte dans les zones à forte endémicité comme les îlots de mangrove.

La Session 4c a été conclue à 16h40, afin de permettre aux participants d'avoir une pause avant le symposium OMS / FIND. Aucune question n'a été posée aux deux premiers orateurs.

Le 13 septembre, Veerle Lejon a ouvert la Session 4c à 8h15 par la présentation du projet DiTECT-HAT. Elle a indiqué que certains défis persistent en rapport avec l'élimination de la THA : i) l'intégration du diagnostic et des soins dans le système de santé général ; ii) la surveillance des foyers éliminés ; et iii) la mise au point de médicaments sûrs et efficaces. Les besoins identifiés par DiTECT-HAT qu'il faut satisfaire pour relever ces défis concernent : i) les tests de diagnostic et les algorithmes adaptés à la détection passive des cas ; ii) la détection précoce des foyers tout en évitant les alarmes inutiles ; et iii) le test de contrôle précis, précoce et non invasif. Les résultats escomptés du projet DiTECT-HAT sont : i) des algorithmes de diagnostic d'un bon rapport coût/efficacité pour une meilleure gestion des cas et des scénarios de test-et-traitement sans confirmation par parasitologie si possible ; ii) le seuil approprié pour déclencher le dépistage actif de cas et la prévention de la réémergence de la THA , sans fausses alarmes ; et iii) un outil d'évaluation précoce des résultats du traitement afin d'accélérer la mise au point des médicaments et améliorer la gestion courante des rechutes. A ce jour, en ce qui concerne le projet de surveillance passive, les procédures opérationnelles normalisées (SOP : Standard Operating Procedures) et le formulaire électronique de rapportage de cas (CRF) ont été élaborés ; des formations ont été dispensées ; et les projets ont démarré en Guinée et en Côte d'Ivoire. Les inclusions devraient commencer en RDC et le TDR de 2ème génération devrait être inclus dans l'étude. Concernant le projet de test de contrôle précoce, les SOP ont été développées et les activités ont débuté dans 4 des 5 sites.

Philippe Büsher a ensuite présenté un exposé sur l'enregistrement numérique des données des participants de l'étude DiTECT-HAT. Dans le cadre de l'intégration du contrôle de la THA dans le système général de santé, il est nécessaire d'améliorer la gestion des données et le contrôle de la qualité. Une application a été développée pour recueillir les données démographiques, cliniques et diagnostiques sur les participants à l'étude au moyen d'un smartphone ou d'une tablette, et transférer les données vers une base de données centrale pour analyse et permettre le contrôle à distance des résultats des tests de diagnostic. Les défis liés au développement de ce type d'application étaient nombreux et consistaient à éviter les licences de logiciels

commerciaux, applicables à la plupart des types de microscopes, applicables aux smartphones ou tablettes Android, saisir les images et les films, assurer un transfert de données sécurisé, assurer une faible consommation d'énergie ... Philippe Büsher nous a ensuite présenté les différentes étapes de saisie des données dans l'application. Après la connexion, on commence à saisir les données sur le patient : renseignements généraux sur le patient, symptômes cliniques, résultats du test sérologique (une image des 3 tests différents par patient doit être prise), les résultats du test parasitologique (si l'un des tests sérologiques est positif). S'il est positif, une vidéo de 4 secondes du trypanosome doit être enregistrée en connectant une caméra au microscope. Les données sont ensuite envoyées au serveur dès qu'une bonne connexion Internet est obtenue. Vous pouvez ne pas réussir à le faire. Mais vous pouvez également transférer les données sur une carte SD et envoyer les données. Les données sont alors disponibles sur le serveur pour analyse.

Mamady Camara a présenté un exposé sur la détection de trypanosomes dans les biopsies de peau, au nom de Mariame Camara. La THA est en voie d'élimination dans de nombreuses régions d'Afrique de l'Ouest. La présence de réservoirs peut expliquer les modèles de transmission. Mais certains foyers de THA sont persistants, en dépit de l'absence d'un réservoir d'animaux. Des études récentes chez la souris font penser à l'existence d'un réservoir anatomique négligé de T.g. gambiense dans la peau. L'objectif de cette étude était de déterminer si les trypanosomes de la peau pouvaient également être trouvés chez les humains. Des biopsies de peau ont été prélevées sur 55 personnes, dont 28 cas de THA parasitologiquement confirmés et 8 individus séropositifs non confirmés. Les signes dermatologiques (comme la dermatite et le prurit) ont été très souvent signalés par les cas de THA. Après le traitement, le prurit était significativement réduit ou avait disparu dans 100% des patients au stade 2. Les biopsies de peau ont été trouvées positives pour les trypanosomes chez 16 cas de THA et 6 individus séropositifs. Les trypanosomes de la peau chez les patients aparasitémiques et surtout dans les cas d'infection latente sont susceptibles de représenter le chaînon manquant responsable du maintien de la transmission du parasite en Guinée. Il est nécessaire de mener des études supplémentaires pour confirmer ces résultats.

Nick Van Reet a présenté un exposé sur de nouvelles amorces de PCR pour une meilleure détection de l'ADN satellite de Trypanozoon dans le sang humain. Les parasites du sous-genre Trypanozoon contiennent des séquences spécifiques d'ADN satellite de 177 paires de bases. Mais un fait surprenant est que ces séquences de répétition de Trypanosoma Brucei (TBR) sont souvent ciblées dans la PCR. Mais cette séquence exacte de 177 pb n'est pas trouvée dans les bases de données du génome Tbg. Au contraire, la séquence originale semble être un mélange de deux principaux groupes ou de répétitions qui sont soit 177 pb soit 176 pb de long. Au cours des études de

prévalence des parasites du Trypanozoon, les scientifiques se plaignaient de la faible sensibilité de la PCR. Sur la base de cette nouvelle information sur la séquence, ils ont développé plusieurs nouveaux ensembles d'amorces TBR pour l'amplification des deux répétitions. Les résultats initiaux montrent que ces nouveaux ensembles d'amorces sont capables de détecter <15 cellules Tbr / mL et <30 cellules Tbg / mL dans des extraits de sang humain « spilked ». Dans les échantillons cliniques, les nouvelles amorces Tbr donnent une forte sensibilité, mais une faible spécificité apparente. Les amorces seront converties en format temps réel.

Les deux exposés qui ont suivi ont porté sur le test LAMP. Boniface Namangala a présenté un exposé sur la détection rapide de trypanosomes infectieux humains dans des échantillons cliniques provenant des vallées fluviales de la Zambie à l'aide du LAMP. Comme la détection précoce de la THA est la clé de la réussite de sa gestion, l'orateur a souligné la nécessité d'une technique de diagnostic plus économique et plus rapide, mais sensible et spécifique. L'objectif de l'étude était d'évaluer l'utilisation potentielle du test d'amplification isotherme médiée par la boucle (LAMP : Loop-mediated isothermal amplification) comme outil de diagnostic rapide de trypanosomes infectieux humains dans les échantillons cliniques des vallées fluviales de la Zambie. Le sang et le liquide céphalo-rachidien ont été prélevés, du sang a été prélevé sur des animaux domestiques, et des mouches tsé-tsé ont été piégées dans les anciens foyers de THA. Deux amorces ont été utilisées dans cette étude, l'une ciblant RIME exprimée par Trypanozoon et l'autre ciblant SRA qui est plus spécifique à T.b. rhodesiense. Le LAMP a été légèrement modifié pour être adapté aux conditions de terrain (LAMP sec). Différentes espèces de trypanosomes infectant les animaux ont été détectées chez les animaux parasitémiques et aparasitaémiques ainsi que chez les mouches tsé-tsé. De plus, le système LAMP a pu distinguer le Tbr d'espèces de trypanosomes étroitement apparentés et le Tbr a été détecté dans le sang et le liquide cérébro-rachidien des patients. Tbr a également été détecté chez les animaux domestiques et les mouches tsé-tsé, ce qui fait penser à leur rôle éventuel dans l'épidémiologie de la THA. Cette étude a permis de sensibiliser davantage le personnel de santé et les résidents locaux à la THA, ce qui a contribué à améliorer le rapportage des cas présumés de THA et par conséquent à sauver des vies. Une surveillance continue de Tbr chez les humains, les animaux domestiques, les réservoirs fauniques et les glossines vecteurs, est nécessaire en Zambie. Le LAMP sec convenable pour le terrain est un outil potentiel de diagnostic et de stadification, et peut être utile dans la prise de décisions thérapeutiques.

Ensuite, Kyoko Hayashida a présenté un exposé sur le développement et l'évaluation d'un nouveau kit LAMP sec pour un diagnostic rapide de la THA. Le test LAMP a encore montré des défis : une étape compliquée d'extraction

d'ADN, la nécessité d'une chaîne de froid pour les réactifs, le coût élevé des réactifs. L'objectif de ce projet était de concevoir un système LAMP plus simple, plus stable et financièrement avantageux. Tout d'abord, un indicateur CFI (Colori Fluorometric Indicator) bon marché et stable à une température ambiante a été développé. Deuxièmement, tous les réactifs ont été séchés dans un tube en utilisant du Trehalose et du Glycerol comme cryoprotecteur. Ce LAMP sec a été testé pour sa thermostabilité (3 jours à 45 °) et est apparu donc plus pratique pour le transport. Troisièmement, grâce au nouveau CFI, la préparation des échantillons a été simplifiée, car il peut être utilisé directement sur le sang. Pour la détection, un détecteur LED fait à la main et bon marché utilisant une batterie a été fabriqué. Après avoir testé un premier prototype du LAMP sec en Zambie dans les conditions de terrain, une production stable / en masse de réactifs LAMP sec avec imprimante à jet d'encre a été développée. Le contrôle de la qualité du LAMP sec fabriqué à la machine a été effectué. Aucune différence n'a été observée entre le LAMP sec conventionnel et celui fabriqué avec une machine en termes de taux de détection. Le temps de réaction a été fixé à 45 minutes pour RIME-LAMP et 30 min pour SRA-LAMP. Enfin, les chercheurs ont voulu savoir si la température de stockage affecte la qualité du LAMP sec. Comme le temps de réaction devient plus long pour l'échantillon stocké à température ambiante, ils recommandent un stockage de longue durée de l'échantillon à 4°. Avec ces améliorations, le diagnostic sur place de la THA devient une réalité car la procédure entière est très simple et bon marché, et des résultats sensibles sont disponibles dans une heure. Dry-LAMP est maintenant en phase de validation dans les cliniques locales ici en Zambie.

Nick Van Reet a présenté un deuxième exposé, sur la diversité des gènes d'aquaglyceroporine (TbAQP) chez le Trypanozoon et leur relation avec la résistance croisée au mélarsoprol et à la pentamidine (MPXR). MPXR est lié à la délétion ou aux mutations dans le gène AQP2, c'est-à-dire la chimérisation d'AQP2 par incorporation de différentes proportions de gène AQP3 en séquence codante AQP2. En effet, les souches T.b. gambiense qui n'ont que des chimères AQP2 / 3 et aucun gène AQP2 de type sauvage présente différents niveaux de MPXR. Les souches de Tbg qui contiennent des chimères AQP2 / 3 mais aussi un gène AQP2 de type sauvage restent sensibles au mélarsoprol et à la pentamidine. La résistance au diminazène, qui ressemble beaucoup à la pentamidine, n'a aucune relation avec les mutations de l'AQP2, mais avec le récepteur AT1. De plus, certaines souches de T. evansi et T. equiperdum, qui n'ont jamais été exposées à la pentamidine ou au mélarsoprol, portent également des chimères AQP2 / 3 mais ne sont pas résistantes à la pentamidine ou au mélarsoprol.

Enfin, Digas Ngolo a présenté, au nom d'Olaf Valverde, l'évaluation clinique de référence pour les patients atteints de g-HAT en RDC et en RCA pendant les

pistes cliniques de DNDi. Trois études cliniques ont été complétées par DNDi, et une est toujours en cours. Au total, 749 patients ont été inclus dans les 3 essais cliniques complétés. La population de l'étude comprend tous les stades de la THA mais n'est pas représentative de tous les cas de THA en raison des critères d'exclusion (femmes gravement malades ou mal nourries, enceintes et allaitantes, enfants <6 ans ...). Les maux de tête étaient les symptômes les plus fréquemment rapportés à l'inclusion (67%), suivis de l'adénopathie cervicale (43%), de l'impuissance ou de l'aménorrhée (1/3 des adultes), de symptômes neurologiques (plus fréquents au 2ème stade) et de la somnolence (11% chez les patients au 1er stade). Il se peut qu'il y ait eu une co-infection aggravante car 36% des cas de THA ont été co-infectés par le paludisme qui provoque de la fièvre et des maux de tête, et 8% ont été diagnostiqués avec une gale ou une autre maladie de la peau susceptible provoquer du prurit. Les signes et symptômes caractéristiques de la maladie du sommeil se manifestent principalement en stade avancé. Comme recommandations, les adénopathies cervicales devraient toujours être explorées, et un examen neurologique approfondi effectué peut aider à orienter le diagnostic, en particulier dans une THA au stade avancé.

Les six questions suivantes ont été posées aux orateurs.

1. ***A Nick qui a mentionné la résistance au Kasai (RDC) : Y a-t-il des facteurs qui favorisent la résistance dans cette province ?***

Il y avait déjà beaucoup de gens au stade 2 avancé. Le niveau élevé d'échec du traitement peut probablement s'expliquer par la mutation, mais il peut aussi être dû au fait que les patients se présentaient à un stade tardif.

Le médicament peut avoir des difficultés à tuer le parasite à ce stade tardif.

2. ***À Veerle : Comment pouvez-vous soutenir les techniciens sur place puisque nous connaissons la forte rotation, encore plus s'il n'y a pas de «motivation»? Devons-nous maintenir cette «motivation» à la fin de l'étude?***

Le projet a démarré il y a seulement 1 mois, donc il est trop tôt pour donner des réponses sur le taux de rotation.

La motivation est décidée selon le pays, par le ministère de la Santé.

3. ***A Veerle : Il y a plusieurs défis dans le domaine : diminution de la prévalence, faible taux d'utilisation des établissements de santé, symptômes frustrants au début de sorte que les malades ne cherchent***

pas de traitement. Comment votre projet sera-t-il utile dans ce contexte ?

Nous ne changerons pas cette réalité. Ce que nous espérons, c'est de changer la PPV en trouvant une combinaison de tests qui, nous l'espérons, vont l'augmenter. Si, à un moment donné, il y a une réémergence, nous comptons également combiner les tests de diagnostic que nous mettrons à la disposition de l'équipe mobile chargé d'effectuer le dépistage réactif.

4. À Philippe : Avec les problèmes de connectivité, les images et les vidéos sont-elles trop lourdes pour le transfert sur Internet ?

Le transfert peut effectivement être un défi. Mais la vidéo elle-même n'est que de 1 Mo, donc pas trop lourde. La connexion est également plus ou moins stable, et les données et les images / vidéos sont également envoyées via 2 voies différentes. Pour le moment, le problème principal est la formation des gens à l'utilisation de l'application.

5. À Kyoko : Comment avez-vous évité la contamination à la suite de la simplification du test LAMP ?

Comme on utilise des amorces très spécifiques, un tel risque de contamination de l'échantillon est inexistant.

6. À Camara, où ont été effectuées les biopsies de peau ?

Nous avons reçu le soutien des dermatologues pour prendre des images et pratiquer des biopsies de peaux.

Session 4c. Stratégies de contrôle et de surveillance & lutte antivectorielle

Modérateur : Mamadou Camara

Rapporteur: Jose Ramon Franco

Priotto a abordé la question de l'intégration de la surveillance passive de la THA pour la documentation de son élimination. Ceci concerne les pays qui avaient précédemment présenté des cas de THA, mais qui n'ont déclaré aucun cas sur plusieurs années subséquentes en dépit des activités de dépistage actif menées. Ce système de surveillance destiné à évaluer l'élimination de la THA doit être durable et donc intégré dans le système de santé. Il doit être complété par un dépistage actif réactif si des cas sont détectés. Il est basé sur l'introduction de TDR dans des établissements de santé sélectionnés (sites sentinelles) et la recherche parasitologique subséquente pour confirmation de cas ou l'envoi d'échantillons pour étude par trypanolyse. Le système de

déclaration a été mis en place. La supervision du système est cruciale. Jusqu'à présent, 113 sites fonctionnent dans 15 pays et seulement 1 cas a été détecté au Burkina Faso.

Mumbo a présenté un exposé sur le déploiement de la stratégie de communication dans le cadre du programme d'intensification de l'élimination de la maladie du sommeil au Soudan du Sud utilisant une stratégie intégrée. Une enquête KAP de référence a été menée dans le comté de Yei, et a tenu compte de sa composition multiculturelle qui comprend les principaux groupes d'Equatoria Central. Cette enquête montre que la population a des connaissances sur la THA, mais avec une certaine désinformation principalement en ce qui concerne la transmission et le risque de maladie. Cette enquête a révélé une stigmatisation des personnes affectées. La majorité des personnes (90%) cherchent des soins dans les établissements de santé fixes. Les posters et les représentations étaient les matériels de communication préférés. Selon les résultats de l'enquête, le matériel d'IEC a été développé (tableaux, brochures, dépliants, spots radio et théâtre), principalement en anglais, mais les animateurs (agents de santé communautaires et autres membres du personnel de la santé et chefs communautaires) peuvent le traduire dans les langues locales. Le matériel IEC a été testé et est actuellement utilisé.

Priotto a présenté une mise à jour du réseau de l'OMS pour l'élimination de la THA comme élément-clé de l'élimination de la maladie. L'importance de la coordination des partenaires pour l'élimination a été soulignée. Le Réseau de l'OMS pour l'élimination de la THA a été réexaminé. Il est basé dans le groupe du réseau rhodesiense et gambiense, qui comprend la réunion des parties intéressées, le groupe scientifique consultatif, les réunions de coordination des pays et différents groupes de coordination de la mise en œuvre.

Selby a présenté les opérations de lutte contre la mouche tsé-tsé comme un élément de la réduction chronique de la THA à Yasa Bonga. Le dépistage actif a été effectué dans la région pendant plusieurs années, ce qui a entrainé une réduction du nombre de cas. En 2015, des cibles minuscules ont été placées dans une zone restreinte le long des rivières, qui a été étendue après un an plus tard au nord et ensuite à l'est. Au total, en juillet 2017, 11 311 cibles minuscules avaient été mises en place. La population de tsé-tsé a été globalement réduite de plus de 80%, ce qui a contribué à réduire le risque de transmission. Les premiers résultats indiquent que la combinaison du dépistage actif et de la lutte antivectorielle est très efficace dans la réduction du fardeau de la THA. L'étude de la répartition spatiale de la THA dans les villages a montré que la maladie et la mouche tsé-tsé ne sont pas présentes dans toutes les parties de la région, ainsi il est possible de concentrer la lutte antivectorielle dans les zones situées autour des villages où le contact avec le vecteur est plus probable.

Rock a expliqué la dynamique de la maladie du sommeil à gambiense à travers la modélisation mathématique comme méthode utile pour quantifier le succès des interventions passées de contrôle de la THA et pour montrer à quoi ressembleront la transmission et le rapportage à l'approche de 2030. La modélisation est un cadre flexible, qui dépend de la fiabilité des données. Elle est utile pour tester les hypothèses et faire des descriptions sur les scénarios hypothétiques pour évaluer les progrès accomplis par rapport aux objectifs d'élimination. Elle peut être utilisée pour mesurer la sous-déclaration et prédire l'impact des stratégies actuelles sur la transmission. Les hypothèses sont nécessaires pour la modélisation et, dans le cas de la THA, il a été supposé que certaines personnes sont piquées davantage par les mouches tsé-tsé et que les animaux pourraient jouer un rôle dans la transmission. Parmi les exemples de cette utilisation, on peut citer les travaux réalisés à Mosango et Yasa Bonga à Bandundu (2000-2012) et à Mandoul au Tchad (2000-2013). Il a été estimé que les stratégies actuelles de détection de cas ont conduit à une réduction de la transmission de la maladie de 53% à Mosango et Bonga Yasa et de 67 - 75% à Mandoul. Le modèle indique que Mosango et Bonga Yasa n'atteindront pas l'objectif de 2030, et on estime que dans certaines régions, les groupes à risque présumés être des facteurs de transmission n'ont pas été couverts par les activités de dépistage actif. Selon les prédictions types, même une réduction modérée de la population de glossines pourrait réduire rapidement la transmission. Les travaux futurs incluent la simulation d'une stratégie future plus réaliste de petite échelle spatiale et les estimations de coûts.

Mansinsa a décrit la transmission de la maladie du sommeil dans la zone de santé de Bonga Yasa. Les lieux de contact vecteur-homme ont été étudiés en fonction des activités habituelles de la population (liées aux activités agricoles et à la pêche). Des glossines ont été trouvées dans les villages et aussi dans les petits vestiges des forêts primaires. Le premier peut être lié à la transmission péridomestique et le second à la ré-invasion des zones précédemment contrôlées.

Session 4d

La Session 4d a été présidée par Alain Mpanya.

Amélioration du dépistage et du diagnostic de la trypanosomiase humaine africaine à gambiense dans le nord-ouest de l'Ouganda – vers l'élimination de la maladie

Présenté par Charles Wamboga, Ministère de la Santé, Kampala, Ouganda

En Ouganda, la charge de la trypanosomose humaine africaine à Gambiense est en diminution, étant passé de 198 cas en 2008 à seulement 4 en 2016. L'un des éléments-clés de la stratégie ayant conduit à cette baisse est la sérologie CATT. Dans 7 districts du nord-ouest de l'Ouganda, une expansion du dépistage passif est mise en œuvre depuis 2013, y compris 212 établissements de santé, qui ont été ramenés à 125 établissements après 2014. La stratégie de dépistage est basée sur des tests diagnostiques rapides (TDR) visant à examiner les patients présentant une suspicion clinique de THA, suivis d'une confirmation par parasitologie au niveau des centres de microscopie situés dans des endroits stratégiques. Pour les patients négatifs par examen parasitologique, les échantillons de sang sont soumis au test LAMP (loop-mediated isothermal amplification), et s'ils sont positifs, ils sont soumis à un nouveau test par parasitologie. Une approche dite mHealth pour la saisie électronique des données est mise en oeuvre en utilisant une application informatique, ce qui améliore le rapportage et la gestion du projet et permet de rappeler aux patients leurs rendez-vous par SMS.

Ce réseau de sites périphériques a réduit à une moyenne de 2,5 km la distance parcourue par une personne malade pour atteindre une structure de dépistage. La distance moyenne jusqu'aux centres de microscopie est de 12,5 km.

Des TDR ont été réalisés sur 27 137 cas cliniques suspects, avec 708 positifs (2,6%) dont 76% ont atteint les centres de microscopie. Les cas confirmés de THA étaient de 19, dont 2 provenant de sites périphériques et 2 autres de cliniques privées.

Une stratégie porte – à- porte ciblée pour la détection de la maladie du sommeil dans les milieux à faible prévalence en Côte d'Ivoire

Auteur de référence : Mathurin Koffi. Présenté par Vincent Jamonneau

En 2012, nous avons effectué une enquête porte-à-porte ciblée (TDD) axée sur la zone immédiatement située aux alentours des anciens patients de THA dans le foyer de Bonon, et les résultats ont été comparés à ceux obtenus lors du dépistage actif classique à grande échelle (AMS).

L'enquête TDD a examiné 1058 personnes vivant dans les environs des 72 anciens cas localisés. Sept personnes étaient positives par trypanolyse et 4 ont été confirmées comme cas de THA. En outre, les 72 anciens cas pourraient avoir être contrôlés (aucune rechute n'a été détectée).

La TDD a détecté beaucoup plus de cas de THA que l'AMS. Le coût était comparable. Ces résultats portent à croire que la TDD est une stratégie efficace et utile dans les milieux à faible prévalence où des cycles de transmission très localisés peuvent persister et, si elle est combinée avec une surveillance passive, elle pourrait contribuer à l'élimination de la THA.

Apport de nouvelles stratégies pour contribuer à l'élimination de la THA : Cas du foyer du Mandoul au Tchad.

Presenter: Mallaye Peka

Le Tchad compte cinq foyers avec une moyenne d'au moins cinquante nouveaux cas notifiés par an depuis 2014. Depuis 2015, de nouvelles approches de lutte contre la THA ont été introduites dans le foyer du Mandoul :

- l'extension du dépistage passive dans les structures sanitaires du district de Bodo;
- le renforcement du dépistage actif par l'intermédiaire d'une équipe mobile à moto utilisant des tests de diagnostics rapides (TDRs), avec un système de référence pour la confirmation parasitologique;
- la lutte antivectorielle avec des petits écrans imprégnés.

En 2015-2016, 120 nouveaux cas ont été dépistés (67 en 2015 et 53 en 2016) dont 72 cas (60%) du foyer du Mandoul. Sur ces 72 cas, 40 (56%) ont été dépistés en passif par les 10 structures sanitaires qui ont intégré l'utilisation des TDRs. Les années précédentes (2013-2014) les structures sanitaires avaient diagnostiqués 101 cas (37%) en passif. Au cours de la période 2015-2016 le dépistage actif par l'équipe mobile à moto a permis de trouver 10 cas (14%) en complément des 32 nouveaux cas diagnostiqués en actif au moyen du CATTwb par l'équipe mobile utilisant les véhicules ; ce qui représente 44% du nombre total des cas notifiés.

Les stratégies qui intègrent les TDRs collaborent à améliorer le dépistage de cas de THA. Leur utilisation dans d'autres foyers de la maladie devrait être soutenue.

Intensification de la surveillance passive de la trypanosomiase humaine africaine dans l'État du Delta au Nigeria

Enwezor, F.N.C

Le dernier cas confirmé de THA au Nigeria a été signalé en 2013. En 2014, NITR, FIND et le Ministère de la Santé du Nigeria ont lancé un programme de collaboration pour mettre en oeuvre le dépistage passif en utilisant les tests de diagnostic rapide de la THA (HAT-RDTs), la microsccopie à fluorescence équipée de LED et le LAMP intégrés dans le système de soins de santé primaires. Cinquante-et-un établissements de santé ont été inclus. En 2016, le nombre d'installations pour les tests de confirmation a augmenté, passant de quatre (4) à 25, réduisant ainsi la distance que les suspects positifs par TDR doivent parcourir pour atteindre un centre de confirmation. En mars 2017, 7 310 patients avaient été dépistés avec les HAT-RDT et 211 (2,89%) étaient positifs, dont soixante-cinq se sont présentés pour les tests de confirmation. Aucun cas de THA n'a été identifié jusqu'à présent. La stratégie a maintenant été ré-examinée en vue d'une surveillance passive plus durable et ciblée dans 19 établissements de santé. Il faut plus de synergie entre les partenaires pour soutenir l'élimination de la maladie au Nigeria.

Distribution géographique des cas de trypanosomiase humaine africaine en République Démocratique du Congo de 2011 à 2015 : analyse des données de l'Atlas de la THA.

Shampa Chansy

La République Démocratique du Congo (RDC) est le pays qui compte le plus grand nombre de cas de trypanosomiase humaine africaine (THA) dans le monde, avec plus de 80% des cas rapportés à l'Organisation Mondiale de la Santé. L'Atlas de la THA constitue un atout majeur pour une meilleure connaissance de la distribution des malades THA, géoreferencés au niveau du village.

De 2011 à 2015, 22 764 cas de THA ont été rapportés par la RDC et les différentes cartes élaborées montrent la situation cumulée des cas et leur répartition par zones de transmission.

Les zones de santé endémiques sont passées de 252 en 2011 à 194 en 2015 sur un total de 516 zones de santé de la RDC. 4105 villages ont déclaré au moins 1 NC THA. 567 villages ont notifié des cas au 1er stade.

L'analyse des données de l'Atlas a permis la planification rationale des activités du dépistage actif en 2016 et 2017. Aussi elle a guidé le choix de 15 sites sentinelles dans la province de la Mongala, le choix de Sites pour les essais cliniques, et des sites pour le projet de la lutte anti-vectorielle (écrans imprégnés)

La constitution de cette base de données et la détermination des zones de transmission de la THA permettent au programme national de mieux planifier les activités de lutte et de surveillance.

Intégration de la trypanosomiase humaine africaine dans les services de santé de base - une étude exploratoire

Mulenga P

Nous avons procédé à cette étude exploratoire de la littérature sur l'intégration de la lutte contre la THA. L'étude a été effectuée sur PubMed de 1977 à 2017 et sur des documents de la littérature grise. 35 documents ont été sélectionnés. Les raisons évoqués pour intégrer la THA étaient des raisons soit épidémiologiques, soit d'efficience, soit d'organisation des soins de santé ou des raisons de pérennisation de la lutte et de l'élimination de la THA. Trois catégories de facteurs influaient sur la mise en œuvre et la maintenance de l'intégration de la THA : les facteurs liés à l'évolution clinique de la THA, les facteurs liés à l'organisation des services de santé et aux utilisateurs et les facteurs liés aux outils diagnostiques et thérapeutiques. Quelques résultats positifs tirés des expériences ont été signalés et plusieurs recommandations étaient formulées dans les documents.

Faisabilité de l'élimination de la THA par amélioration de la couverture en dépistage avec des méthodes innovantes en République Démocratique du Congo (RDC).

Mpanya Alain

Introduction

Dans deux zones de santé en RDC, Yasa-Bonga et Mosongo, le projet « TRYPELIM » est implémenté (2016-2018) afin d'évaluer la faisabilité de l'élimination de la THA en augmentant la couverture en dépistage avec des approches innovantes.

Pour planifier le dépistage actif, on a produit des cartes avec les villages endémiques des 5 dernières années plus les villages sans cas situés dans un rayon de 5km autour. Le dépistage a été porte à porte avec des mini-équipes et avec des campagnes de masse avec la grande équipe classique. On a aussi introduit des tests de diagnostic rapides dans les centres de santé. La collecte des données est faite avec une application mobile qui alimente le système de prise de décision.

La population examinée est montée de 83.808 à 196.622 personnes la première année du projet. 62% a été examiné avec les mini-équipes. On a identifié 3.406 suspects sérologiques dont 2.920 (86%) par les mini-équipes. 50 nouveaux cas ont été diagnostiqués dont 13 (26%) par les mini-équipes. 4 cas proviennent des villages considérés non-endémiques.

Cette approche a permis d'améliorer la couverture.

S'assurer que les réfugiés ne sont pas laissés à la traîne dans l'élimination de la maladie du sommeil : leçons de gouvernance en Ouganda

Jennifer Palmer

Il est essentiel de se demander si les populations déplacées et les ressortissants nationaux ont un accès équitable aux mêmes ressources sanitaires. La comparaison de l'utilisation des TDR entre les populations hôtes et les réfugiés peut être un marqueur d'un « accès différentiel ».

Il existe des complexités de communication supplémentaires lorsqu'on travaille avec des migrants forcés. Les difficultés de communication causées par les différences entre les langues et les cultures ont rendu difficile le dépistage d'une maladie atypique sur base de symptômes.

Les organismes humanitaires participent de moins en moins aux activités liées à la THA, laissant aux programmes gouvernementaux et aux partenariats une responsabilité croissante, pour s'assurer que les populations déplacées ne sont pas marginalisées. Les stratégies de surveillance de l'élimination dépendent de technologies imparfaites qui sont contrôlées par des individus. Nous devons prendre en considération les comportements sociaux lors de l'interprétation des données de surveillance.

REPORT AND RECOMMENDATIONS FOR AFRICAN ANIMAL TRYPANOSOMIASIS

Report session 5a: Epidemiology

Only eleven out of the seventeen planned topics were presented during the session, and the diversity of subjects was one of the attractions to this session on AAT. These included control, risk factor analysis prevalence, vector control, disease re-emerging factors, wild animals as reservoir.

A keynote presentation was presented by FAO East Africa on the importance of PCP (Progressive Control Pathway) and its application at member state that can be cascaded at regional and continental level, and this was followed by others presentations on the prevalence and incidence of the disease in certain parts of Africa. A point note was made on the possibility that a domestic animal like dog can also be a possible reservoir of the disease. Around some game reserves, there is possibility for cattle to become a reservoir for HAT. The increasing phenomenon of fake trypanocide drugs on the market and even is their apparition in the official clinic has become a source for concern.

Recommendations:

Many recommendations emerged from the discussions conducted in this session:

1. It's time to find tools to control stomoxys because it's becoming clear that they are the principal cause of the mechanical transmission of diseases in many cleared areas.
2. A point note was made on the possibility that a domestic animal like a dog can also be a possible reservoir of the disease.
3. There is a possibility for cattle to become a reservoir for HAT around certain game reserves on the continent.
4. The need to put in place testing labs for fake trypanocides, because this is an increasing source of concern.

RAPPORT ET RECOMMANDATIONS SUR LA TRYPANOSOMIASE ANIMALE AFRICAINE

Rapport de la session 5a : Epidémiologie

Sur dix-sept sujets prévus, seuls onze ont été présentés au cours de cette session, et la diversité des sujets a été l'une des attractions à cette session sur la TAA. Les sujets comprennent le contrôle, l'analyse des facteurs de risque, la prévalence, la lutte antivectorielle, les facteurs de réémergence de la maladie, les animaux sauvages comme réservoir de la maladie.

La FAO - Afrique de l'Est a présenté un exposé thématique sur l'importance de l'approche de lutte progressive (PCP : Progressive Control Pathway), et son application dans les États membres qui peut être répercutée aux niveaux régional et continental. Cet exposé a été suivi d'autres exposés sur la prévalence et l'incidence de la maladie dans certaines parties de l'Afrique. On a évoqué la possibilité qu'un animal domestique comme un chien soit également un réservoir éventuel de la maladie. Autour de certaines réserves animalières, il est possible que le bétail devienne un réservoir de la THA. Le phénomène de la croissance de faux trypanocides sur le marché et même leur apparition dans les cliniques officielles est devenu un sujet de préoccupation.

Recommandations

Beaucoup de recommandations ont été formulées à l'issue des discussions conduites durant cette session :

1. Il est temps de trouver des outils de contrôle des stomoxys, car il est devenu manifeste qu'ils constituent la principale cause de transmission mécanique de maladies dans de nombreuses zones.
2. Un point a été évoqué sur la possibilité qu'un animal domestique comme un chien soit également un réservoir éventuel de la maladie.
3. Il est possible que le bétail soit un réservoir de THA autour de certaines réserves animalières sur le continent.
4. Il est nécessaire de mettre en place des laboratoires d'analyse ciblant les faux trypanocides, car ceux-ci sont devenus une source de préoccupation croissante.

Report session: Poster

During this session, only 19 posters out of the planned 25 were displayed. It was noted that delegates had not preliminarily viewed the posters, certainly because of lack of time. Since no questions were raised during this session, we

gave each poster exhibitor the opportunity to summarize the contents of his/her poster in five minutes and to focus on conclusions and recommendations, which is an innovation during this 34th conference. Thus, several themes, ranging from the treatment of the disease to vector control, platform for stakeholders in HAT treatment, factors influencing the transport of pulps, circulation of vectors, wild reservoirs of the disease and domestic animals as potential reservoirs, were discussed during this session.

At the end of the session, delegates were requested to go to the poster room. Exhibitors had to show their poster. At the end of this exercise, delegates had to choose the 3 best posters.

After counting the choices made by the delegates, the following posters were selected:

1st : Poster 3.20

2nd : Poster 3.22

3rd : Poster 4.26

Recommendations:

Two major recommendations emerged from discussions:

1. Stomoxys mechanical vectors are partly responsible for animal trypanosomiasis in areas cleared of tsetse flies, the biological vectors of the disease.
2. For the next conferences, the poster session should first start with a visit to the posters, with the author standing near his/her poster and providing a comment on it. Then in the room every exhibitor should be given the opportunity to summarize his/her work in 5mn, which will be followed by questions and the vote for the best poster.

Rapport de la session sur les posters

Durant cette session seulement 19 posters sur les 25 prévus ont été expose. Nous avons fait le constat que les délègues n'avais pas au préalable consulté les posters certainement par manque de temps puisque cette session ne susciter pas les questions nous avons donnée l'opportunité à chacun des exposants de résumer en cinq minute son poster en insistant principalement sur les conclusions et recommandations ce qui est une innovation pour cette 34th conférence. Ainsi plusieurs thèmes allant du traitement de la maladie, du control des vecteurs de la maladie, de la plateforme des intervenants dans le traitement des THA, les facteurs qui influencent le transport des pulpes,

de la circulation des vecteurs, des réservoirs sauvages de la maladie et de la possibilités des animaux domestiques comme potentiels réservoirs ont été abordé durant cette session.

A la fin de la session il a été demande aux délègues de se rendre dans la salle des posters et que chaque présentateurs expose son poster. A la fin de cet exercice les délégués devaient choisir les 3 meilleurs posters.

Apres dépouillement du choix de l'ensemble des délégués est le suivant :

1er : Poster 3.20

2e : Poster 3.22

3e : Poster 4.26

Recommandations :

Deux grandes recommandions ressorte des discussions :

1. Les vecteurs mécaniques stomoxes sont en partie responsables de la trypanosomose animale dans les zones assainies de mouche tsétsé vecteurs biologiques de la maladie.
2. Pour les prochaines conférences la session des posters doit d'abord commencer par une visite des posters avec son commentaire par l'auteur qui doit être a cote et ensuite en salle on donne l'opportunité a chaque auteur de résumé son travail en 5mn qui seront suivie par les question et le vote des meilleurs poster finalement.

GLOSSINA BIOLOGY, CONTROL AND ERADICATION

Moderator: Rajinder Saini (7a)

Moderator: William Shereni (7b)

Rapporteur: Baba Sall

The session started by a symposium "New insights from tsetse biology for evidence based HAT control.

Two presentations were done to show tools based in populations genetics and Chemo-ecological and chemo-sensory responses in tsetse flies which can be used to control tsetse population and HAT.

After the symposium the theme 4 started by a keynote "Maximizing opportunities for integrated tsetse and trypanosomiasis control and elimination" by Dr. Rajinder Saini.

Repellents, Tiny targets, larviposition pheronomes, feeding behavior, Tsetse genome & biological control, new baits for surra control were the main tools developed in the presentation.

Following that 11 other presentations were done regarding tsetse biology and behavior, tsetse distribution update according to climate and land use changes and trypanosomiasis control were done.

Statements/Recommendations

- Molecular Biology and Genetics have stimulated some interest. Future studies to develop new transmission vaccines using metacyclic antigens are encouraging and need to be followed up. Genomics based studies to guide tsetse control strategies /interventions need to be followed up.

- The General Conference was highly encouraged by the development, evolution and progress made in Kenya in the registration of the tsetse repellent and recommends that these be further optimized in different ecological zones and different species including potential role in the control of riverine tsetse for the integrated control of HAT.

- In view of the position that tsetse larviposition pheromones are widely present in different tsetse species, this needs to be further investigated to determine the potential role in the aggregation of gravid females or pupae.

- SAT continues to be a viable tool for the suppression and eradication of tsetse and its use is recommended wherever suitable.

- Tsetse control interventions should take into consideration spatial distribution and trypanosome infection in order to maximise cost-benefit ratios in the control of AAT.

- Tsetse control interventions should take into consideration community based approach to ensure sustainability

- The new tools presented should be taken into consideration for T&T control and to update tsetse distribution according to climate and land use changes. Considering the link between tsetse distribution and climate changes and T&T control and employment the related institutions should be approached for funding

- Non-tsetse transmitted trypanosomiasis continues to be an important area and it is recommended that the efforts should be doubled in the development of new olfactory and visual baits for the control of these vectors to maximise control of T. evansi infections

- There are no silver bullets in tsetse control. Expert knowledge and predictive modelling are a necessity, to assess strategic matters such as the appropriate size and shape of operational area, operational objectives, tsetse species and invasion pressures that occur in different situations.

- Even when the strategy is optimized, there is still a need to make tactical decisions such as exactly what type of technology or technologies to use, at what density, under what management regime and for how long. For this exerts are required and Capacity building. is required at all levels as Unfortunately, the number of experts available to help at these levels is not only small but is declining.

BIOLOGIE, CONTRÔLE ET ÉRADICATION DES GLOSSINES

Modérateur : Rajinder Saini (7a)

Modérateur : William Shereni (7b)

Rapporteur : Baba Sall

La session a débuté par un symposium intitulé « Nouvelles connaissances de la biologie des glossines pour le contrôle de la THA basé sur des données factuelles » fondée sur des preuves.

Deux exposé ont été présentés pour montrer des outils basés sur la génétique des populations et les réponses chimio-écologiques et chimiosensorielles des glossines qui peuvent être utilisées pour contrôler la population de mouches tsé-tsé et la THA.

Après le symposium, les travaux sur le thème 4 ont débuté par un exposé thématique intitulé « Maximiser les possibilités de contrôle et d'élimination intégrés des glossines et des trypanosomoses» par le Dr. Rajinder Saini.

Les répulsifs, les cibles minuscules, les phéronomes de larviposition, le comportement alimentaire, le génome et le contrôle biologique des mouches tsé-tsé, de nouveaux appâts pour le contrôle du surra ont été les principaux outils abordés dans l'exposé.

Par la suite, 11 autres exposés ont été présentés sur la biologie et le comportement des mouches tsé-tsé ; et une mise à jour sur leur distribution sur la base des changements climatiques et de l'utilisation des terres et du contrôle de la trypanosomiase a été également fournie.

Constatations / Recommandations

- La biologie moléculaire et la génétique ont suscité un certain intérêt. Les études futures visant à développer de nouveaux vaccins utilisant des antigènes métacycliques sont encourageantes et doivent être poursuivies. Les études basées sur la génomique visant à guider les stratégies / interventions de contrôle des glossines doivent faire l'objet d'un suivi.

- Les participants à la Conférence générale ont été très encouragés par les faits nouveaux, l'évolution et les progrès accomplis par le Kenya dans l'enregistrement des répulsifs contre les tsé-tsé et recommandent que ces répulsifs soient optimisés davantage dans différentes zones écologiques et pour différentes espèces, y compris un rôle potentiel dans le contrôle des glossines fluviales en vue de la lutte intégrée de la THA.

- Etant donné que les phéromones de larviposition des glossines sont largement présentes chez différentes espèces de mouches tsé-tsé, il convient d'étudier de manière plus approfondie ce phénomène afin de déterminer leur rôle potentiel dans l'agrégation des femelles gravides ou des pupes.

- La technique SAT reste un outil viable pour la suppression et l'éradication des glossines et son utilisation est recommandée dans toutes les situations où elle est appropriée.

- Les interventions de lutte antiglossinaire doivent prendre en considération la distribution spatiale et l'infection trypanosomique afin de maximiser les rapports coûts / avantages dans la lutte contre la TAA.

- Les interventions de lutte antiglossinaire doivent prendre en considération une approche communautaire pour assurer la durabilité des résultats.

- Les nouveaux outils présentés doivent être pris en compte dans le contrôle des T & T et pour mettre à jour la distribution des glossines sur la base des changements climatiques et de l'utilisation des terres. Compte tenu du lien qui existe entre la distribution des glossines et les changements climatiques et le contrôle des T & T et l'emploi, les institutions concernées devraient être sollicitées pour contribuer à l'effort de financement.

- La trypanosomiase non transmise par les glossines reste un domaine important, et il est recommandé de redoubler d'efforts pour mettre au point de nouveaux appâts olfactifs et visuels pour le contrôle de ces vecteurs afin d'optimiser la lutte contre les infections à T. evansi.

- Il n'y a pas de solution magique dans le contrôle des glossines. Des connaissances spécialisées et une modélisation prédictive sont nécessaires pour évaluer les questions stratégiques telles que la taille et la forme appropriées de la zone de l'opération, les objectifs de l'opération, les espèces de glossines et les pressions d'invasion se produisant dans différentes situations.

- Même lorsque la stratégie est optimisée, il reste nécessaire de prendre des décisions tactiques, déterminer par exemple le type de technologie ou de technologies à utiliser, la densité d'utilisation, le régime de gestion et la durée d'utilisation. À cet effet, des experts sont nécessaires, ainsi que le renforcement des capacités à tous les niveaux, car malheureusement, le nombre d'experts disponibles susceptibles d'apporter leur assistance à ces niveaux est non seulement faible, mais aussi en diminution.

LAND USE ENVIRONMENT & SOCIO-ECONOMICS

Moderator: Wisal ELNOUR M. ELHASSAN

Rapporteur: Lisette KOHAGNE TONGUE

The session started with key notes presentation on the "Impacts of land use, environment and climate changes on the dynamics of T&T and derived socio-economic benefits".

Then followed five (5) communications related mainly to the impact of tsetse and trypanosomiasis in animal production, knowledge of local populations on T&T control and benefits of T&T control on animal production. An issue of a probable role of wildlife activity in the increase of tsetse flies density closed the presentation phase. It was noted the following points:

1. Tsetse distribution ecological models have been developed. People should take advantage of it to target tsetse eradication;
2. Trypanosomiasis seriously affects goat production and productivity and the bigger concern is mortality.
3. Pastoralists are well aware on attitudes and practices of T&T control. Increase of outcome of populations from T&T freed areas is obvious and that positive impact can be quantified.
4. Wildlife activities can enhance tsetse flies density.

At the end of the different presentations followed by a general discussion, the following two points seem to emerge:

- Land use is not always positive. People should incorporate sustainability in their land use system.
- Socio economic impact of T&T control must be carried out to motivate local communities' involvement.

Recommendation:

Acknowledging the impact of land use change, which may either enhance or harm the environment following tsetse control, the meeting agreed that sustainable land use should be incorporated in all tsetse control/eradication programs. Collection and collation of quality data with an effective M&E Plan are highly encouraged for impact assessment within affected communities.

UTILISATION DES TERRES, ENVIRONNEMENT & SOCIOÉCONOMIE

Modérateur : Wisal ELNOUR M. ELHASSAN

Rapporteur : Lisette KOHAGNE TONGUE

La séance a débuté par la présentation d'un exposé principal sur « Les effets des changements de l'utilisation des sols, de l'environnement et des changements climatiques sur la dynamique des T&T et les avantages socio-économiques qui en découlent ».

Par la suite, cinq (5) exposés portant principalement sur l'impact des glossines et des trypanosomoses sur la production animale, les connaissances des populations locales en matière de contrôle des T & T et les avantages du contrôle des T & T pour la production animale. La question du rôle probable de l'activité faunique dans l'augmentation de la densité des glossines a clôturé cette phase des exposés. Les points suivants ont été notés :

1. Des modèles écologiques de distribution des glossines ont été élaborés. Les gens devraient en profiter pour cibler l'éradication des glossines ;
2. La trypanosomiase affecte sérieusement la production et la productivité des chèvres, et la mortalité est la principale source de préoccupation ;
3. Les pasteurs connaissent bien les attitudes et les pratiques en matière de contrôle des T & T. L'augmentation des résultats pour les populations des zones libérées de T & T est évidente, et l'impact positif peut être quantifié ;Les activités de la faune peuvent augmenter la densité des glossines.

À la fin des différents exposés, les discussions générales ont fait ressortir les deux points suivants :

- L'utilisation des terres n'est pas toujours positive. Les gens devraient intégrer l'aspect durabilité dans leur système d'utilisation des terres.
- Une analyse de l'impact socio-économique du contrôle des T&T doit être effectuée pour motiver la participation des communautés locales.

Recommandation

Reconnaissant l'impact des changements dans l'utilisation des terres, qui peuvent améliorer ou nuire à l'environnement après le contrôle des glossines, les participants à la réunion ont convenu d'un commun accord que l'utilisation durable des terres doit être intégrée à tous les programmes de contrôle /

d'éradication des glossines. La collecte et la compilation de données de qualité assorties d'un plan de suivi et d'évaluation (S & E) efficace sont fortement encouragées pour l'évaluation d'impact au sein des communautés affectées.

REGIONAL AND COUNTRY REPORTS

RAPPORTS NATIONAUX ET REGIONAUX

RAPPORT NATIONAL 2016-2017 – ZAMBIE

COUNTRY REPORT 2016-2017 – ZAMBIA

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Résumé

L'on estime qu'une superficie de 280 km2 (38%) du territoire terrestre de la Zambie est infestée de glossines et que le pays est affecté à la fois par les formes animale et humaine de la trypanosomiase transmise par la mouche tsé-tsé. Cependant, c'est en grande partie la trypanosomiase animale (TAA) qui constitue la base de la quasi-totalité des interventions majeures contre les mouches tsé-tsé depuis l'époque coloniale. La TAA affecte principalement les provinces du Sud, de l'Ouest et de l'Est, essentiellement en raison de la présence de la plus grande proportion de bovins exposés au risque d'infection par la maladie dans ces provinces. En conséquence, ces provinces ont été la cible de la plupart, sinon de l'ensemble, des principales interventions (activités) de lutte contre le problème de la mouche tsé-tsé et de la trypanosomiase dans le pays.

Depuis la fin de l'année 2015, deux des principales activités de lutte contre la mouche tsé-tsé et la trypanosomose ont été centrées sur les plans visant à commencer par des opérations de contrôle de la mouche tsé-tsé orientées sur l'éradication dans la ceinture orientale de glossines, c'est-à-dire : (1) les enquêtes sur les glossines et les trypanosomiases couvrant quelque 4000 km2 dans quatre districts de la province orientale, avec une attention particulière aux zones ayant fait l'objet d'opérations d'envergure de contrôle de la mouche tsé-tsé dans les années 1990 - c'est-à-dire dans le but de vérifier l'ampleur et la gravité actuelles de l'infestation tsé-tsé dans la zone concernée ; (2) les enquêtes de base dans l'extrême ouest de la ceinture orientale de glossines, c'est-à-dire la vallée de Luano (premier bloc de pulvérisation proposé), en préparation à la première opération de pulvérisation aérienne dans la ceinture, prévue pour 2017. Les autres tâches majeures exécutées étaient celles associées au bloc de pulvérisation de 2014, c'est-à-dire la maintenance de la barrière tsé-tsé dans la zone, et les enquêtes de suivi de la situation dans la région en ce qui concerne la présence de mouches tsé-tsé et la prévalence de la trypanosomose. Le rapport présente (i) les résultats et ou conséquences notés à la suite de ces opérations, ainsi que les explications probables de celles-ci, (ii) les principaux défis non relevés, et (iii) les lignes d'action proposées.

Abstract

An estimated 280km2 (38%) of Zambia's land area is tsetse infested, and the country is affected by both the animal and human forms of tsetsetransmitted trypanosomiasis. However, it is largely Animal trypanosomiasis (AAT) that forms the basis for almost all the major interventions against tsetse flies since the colonial era. AAT affects mostly the Southern, Western and Eastern provinces, largely because these provinces have the largest proportion of cattle exposed to the risk of infection with the disease. As a consequence, these provinces have been the focus of most, if not all, of the major interventions (activities) against the tsetse and trypanosomiasis problem in the country. Since the end of 2015, two of the major tsetse and trypanosomiasis control activities have been centered on plans to make a start with eradication oriented tsetse control operations in the eastern tsetse belt, i.e.; (1) Tsetse and trypanosomiasis surveys covering some 4000km2 in four districts in the eastern province, with particular attention given to areas that had been subjected to major tsetse control operations in the 1990s – i.e. with the objective of checking/verifying the current extent and magnitude of the tsetse infestation in the respective area; (2) Baseline surveys in the west-most portion of the eastern tsetse belt, i.e. the Luano valley (proposed first spray block), in preparation for the first aerial spraying operation in the belt, that had been planned for 2017. The other major assignments executed were those associated with the 2014 spray block, i.e. maintenance of the tsetse barrier in the area and, surveys to monitor the situation in the area with regard to tsetse presence and trypanosomiasis prevalence. The report presents, (i) the findings/outcomes through or from these assignments and also the likely explanations for these, (ii) the major challenges that prevailed, and (iii) the proposed way forward.

1. Introduction

An estimated 280 000km2 of Zambia's land area is infested with tsetse flies (figure 1), and both the animal and human forms of trypanosomiasis occur in the country. Animal African Trypanosomiasis (AAT) remains the most important and affects mostly the Southern, Western and Eastern provinces of the country, largely because the cattle population is concentrated in these areas. Consequently, the three provinces have been the focus of tsetse and trypanosomiasis control activities in the country over the years. Although Zambia has historically seen outbreaks of Human African Trypanosomiasis (HAT) in several foci, HAT has not been considered a significant health problem and as such it has received comparatively much less attention.

In 2013, there was an outbreak of human trypansosomiasis in Rufunsa district in Lusaka province, in an area that falls in the Luano valley which constitutes the west-most portion of the Eastern Tsetse Belt. The outbreak saw seven (7) cases of the disease confirmed, with one fatality, within a 3-month period.

In their efforts to deal with the challenge, the Ministry of Health requested for assistance from the ministry of Fisheries and Livestock with regard to implementation of an intervention that could effectively deal with the situation. It was against this background that the Tsetse and Trypanosomiasis Control Unit was tasked to prepare a proposal on the best way to deal with the challenge in the area. Noting that there were indications that the area (Luano valley) was separated from the tsetse infestations of the Luangwa and Zambezi valleys, it was proposed to take the option of eliminating the flies from the whole of the Luano valley, and a proposal was prepared in that regard. In 2016, government provided funding to facilitate implementation of the operation. Consequently, this called for collection collection of the necessary baseline sample and data collection with regard to the tsetse and trypanosomiasis status in the area, and also for Environmental Impact Assessment (EIA).

Another set of main activities were implemented in the area that was subjected to aerial spraying operation in 2014, in the western part of the country (in the Kwando-Zambezi tsetse belt) under the Kwando-Zambezi Regional Tsetse Eradication Project. These were, surveys to check whether the area had remained free monitor the status in the respective area had remained tsetse free, and also maintenance of the tsetse barrier that was put in place as a precautionary measure in relation to the proximity of the Kafue tsetse belt.

Among the other activities were, (i) a 'training of trainers' based course on application of open-source GIS in tsetse and trypanosomiasis control, provided by the PATTEC Coordination Office to a small group of T&T control personnel in Zambia, (ii) an in-house training course on field techniques/ methods applied in tsetse and trypanosomiasis surveys, funded by the World Bank supported Livestock Development and Animal Health Project (LDAHP) in the country, and (iii) provision of PCR equipment and training by the IAEA to the Kakumbi Tsetse & Trypanosomiasis Research station located in the Luangwa valley in Eastern Zambia.

The main challenges were associated with the relatively low and inconsistent level of funding, difficulties with tenders processes, low levels of knowledge and skills, etc., and these contributed to limiting capacity to effectively implement and achieve the respective objectives as set in the strategy and work plans.

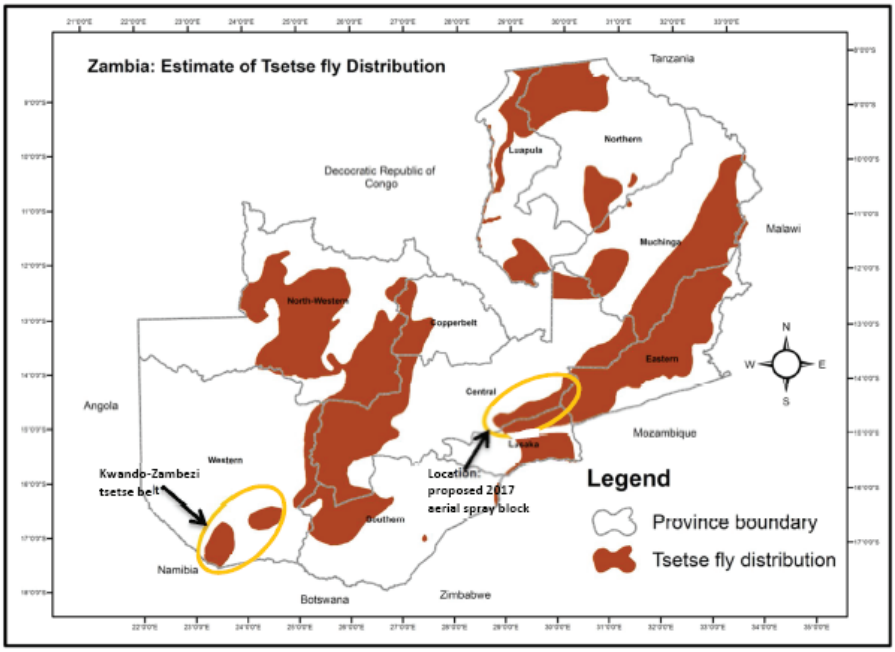


Figure 1. *Estimate - Tsetse infested area in Zambia*

2. Major activities

The major activities undertaken were as follows;

2.1 Processing of tenders - hire of key services for planned aerial spraying operation

Following completion of the main tsetse control operations under in the Kwando-Zambezi tsetse belt, implemented under the Kwando-Zambezi Regional Tsetse Eradication Project, the country proposed making a start with similar operations in the Eastern Tsetse belt, with the first spray block covering the Luano valley (~9,300km2) as indicated in figure 1. With the necessary resources allocated for the operation in the 2016 budget, processing of tenders was one major activity undertaken in respect of the services 'provision of night-time flying services' and 'Supply of insecticide'. The process could not be concluded in 2016 and as such continued through to 2017.

2.2 Monitoring tsetse & Trypansomiasis status in the 2014 spray block

A tsetse and trypanosomiasis survey was undertaken in the 2014 aerial spray block, as part of monitoring of the area to verify continued absence of the tsetse and trypanosomiasis problem. The outcome was as shown in figures 2a and 3, i.e. no tsetse fly and no case trypanosomiasis were detected inside the

spray block. This suggested that the area had remained free from the problem.

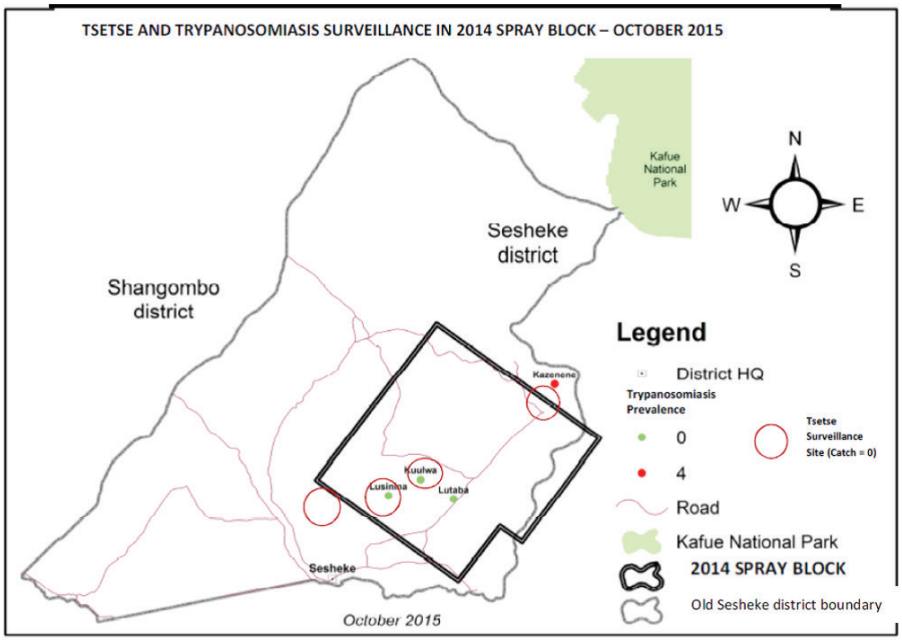


Figure 2a. *Results – Tsetse & Trypanosomiasis survey in 2014 spray block (as at July 2017)*

2.3 Maintenance of tsetse barrier in 2014 spray block

During the aerial spraying operation of 2014, a tsetse barrier (with odour-baited targets) was established at the north-eastern edge of the spray block as a precautionary measure considering the proximity of the Kafue tsetse belt in the east (Figure 2b). In 2016, the targets in the respective barrier were subjected to the scheduled maintenance work.

2.4 Baseline tsetse and trypanosomiasis Surveys and Surveillance in proposed 2017 aerial spray block

As indicated above, it was planned to implement an aerial spraying operation for tsetse control in the west-most section of the Eastern Tsetse Belt (figure 1), the Luano valley, an area that was/is considered relatively isolated (presence of physical barriers) from the rest of the tsetse belt. In 2013/14, seven cases of human trypansomiasis were confirmed from the area, with one fatality. In their effort to address the problem, the Ministry of Health relayed a request to the ministry of Fisheries and Livestock for assistance to address the problem. It was against this background that the proposal to undertake elimination of the flies from the affected valley (the Luano valley), was submitted and later allocated the necessary funds.

As per requirement in plans for such operations, a baseline survey was undertaken to establish the prevailing situation in the area with regard to the tsetse and trypanosomiasis problem in the area. The outcome was as shown in figure 3.

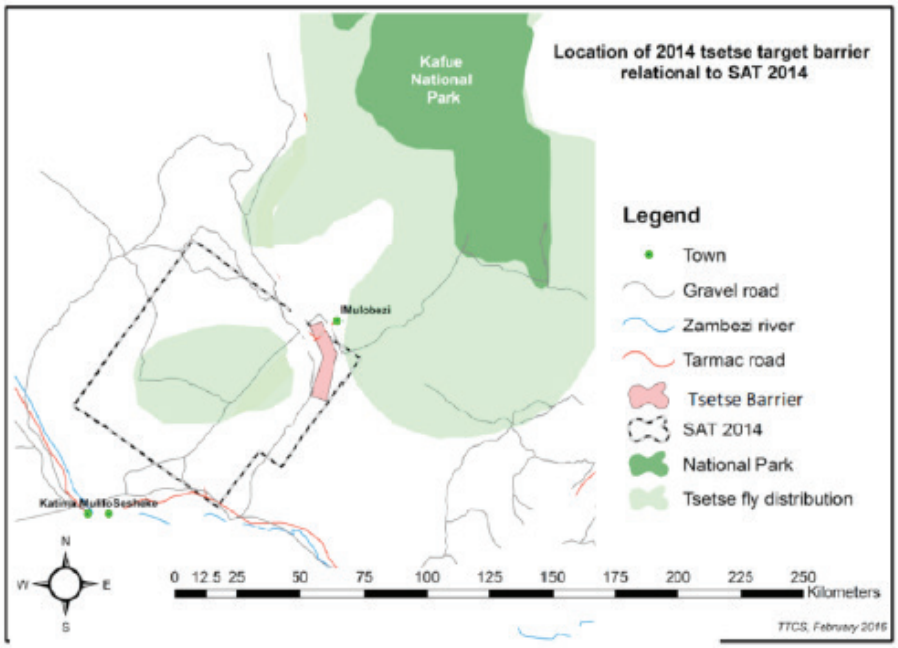


Figure 2b: *Location of tsetse barrier relative 2014 spray block*

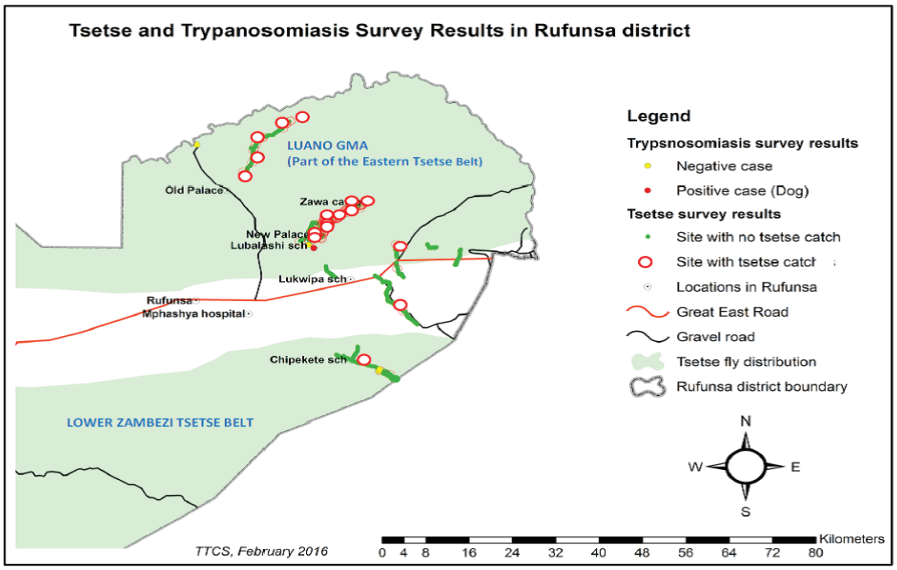


Figure 3. *Results – Baseline Tsetse & Trypanosomiasis survey in parts of Rufunsa district in proposed 2017 aerial spray block (parts of Rufunsa district)*

2.5 Baseline survey for Environmental Impact Assessment (EIA)

By law in Zambia, an environmental impact assessment (EIA) is a must whenever there is an undertaking such as the particular large-scale aerial application (spraying) of insecticide for tsetse control of 2014. Sample and data were collected in two sites that were similar in terms of vegetation cover, one inside the block and the other outside (as control). Sample and data collection were on the following;

a. Status with regard to Land/Vegetation cover and human settlements
b. Status with regard to terrestrial invertebrates
c. Status with regard to key terrestrial vertebrates
d. Status with regard to water bodies and aquatic organisms

The activities were undertaken by teams that included specialists from respective specialised government departments responsible for fisheries, forestry and wildlife. The data/samples and sample were looked at and analysed accordingly and the information deduced is to serve as baseline for comparison with similar sample/data to be collected during and after implementation of the aerial spraying operation.

2.6 Tsetse and Trypanosomiasis Survey in parts of the Eastern Tsetse Belt subjected to tsetse control operations during the period 1988 – 2000.

During the period 1988 to 2000, an area covering about 2,000km2 of the relatively densely populated plateau section of the Eastern Tsetse Belt, was systematically subjected to tsetse control operations with application of odour-baited targets. The operations were implemented by the Regional Tsetse and Trypanosomiasis Control Project (RTTCP), funded by the European Economic Community (EEC) (now European Union). The operations proved very effective such that the disease (trypanosomiasis) had been brought well under control in the area by the year 2000. A survey was undertaken in the particular area in 2016, to assess the prevailing situation noting that so much had changed with regard to land cover and land use, human and livestock population density etc. Ultimately, the main objective was to check the status with regard to the current limits of tsetse infestation in the area. The outcome was as indicated in figure 4. The results suggested that the extent of tsetse infestation may no longer be as estimated in the maps of Ford and Katondo – i.e. that the tsetse belt may have diminished in terms of extent, in the respective area.

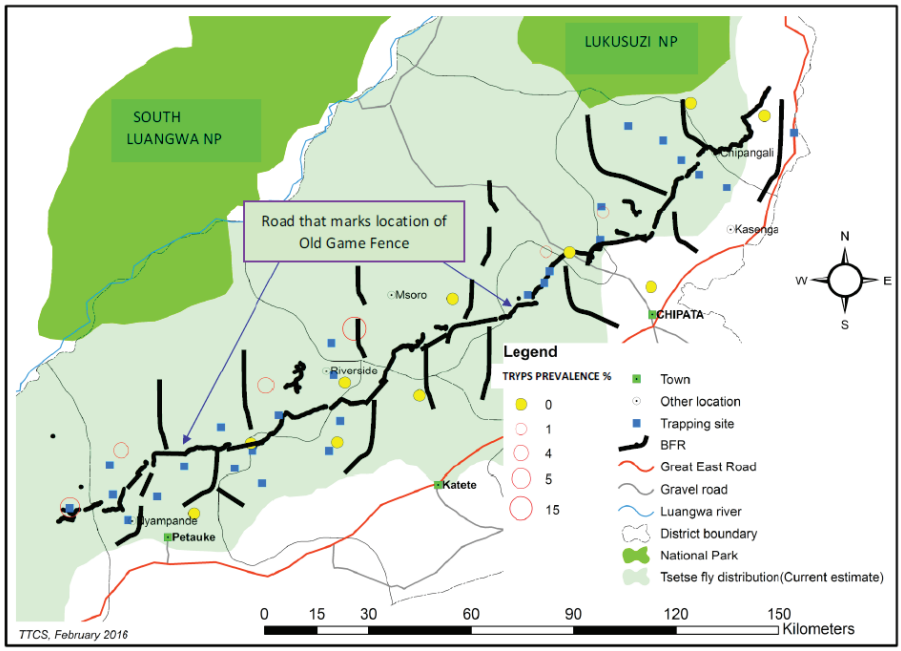


Figure 4: *Results: Tsetse and Trypanosomiasis Survey in the plateau parts of the Eastern tsetse belt*

3 Other notable activities/events

3.1 IAEA support to Kakumbi Tsetse and Trypanosomiasis Research Station

The IAEA provided technical support to the country in form of PCR and related laboratory equipment and consumable to the research station indicated above. In addition, the agency provided relevant training to team of local tsetse and trypanosomiasis control personnel, including those working at the respective research stations. Through this support, a PCR laboratory was established at the station.

3.2 Training on Application of Open-source GIS software in tsetse & trypanosomiasis control, and GIS and Remote Sensing tools to assess/ measure to environmental factors /variables in relation to T&T control. The five-day 'Training of trainers' programme was provided by the PATTEC coordination office to a group of five personnel working under the Tsetse and Trypanosomiasis Control Unit in the country.

3.3 In-house training course on Tsetse & Trypanosomiasis surveys, for field technical personnel (mostly Tsetse Control Assistants). The five-day

training programme was centred on field practical knowledge and skills with regard to implementation of such surveys, and it was funded through the World Bank supported Livestock Development and Animal Health Project (LDAHP). A total of 20 personnel participated in the course.

4 Main challenges

Mainly;

- Levels and rate of release (availability) of funding has not been adequate to support the desired systematic and effective implementation of current strategy & annual work plans
- Difficulties with keeping tender processes within the timeframe of implementation (season) for activities such as aerial spraying for tsetse control in the context of
- Limited level of exposure to knowledge and skills, among T&T control personnel – particularly personnel recruited after the year 2000.
- Non-availability of Socio-economic data/information on impact of trypanosomiasis and benefits of control

5 Way forward

Largely due to delayed completion of the procurement process (tenders) for the key services require in the implementation of the planned aerial spraying operation, the aerial spraying operation could not be implemented in 2017 as planned. The operation has since been rescheduled to the cool-dry season of 2018. In the long-term plan, it is intended to work at building on the work that is to be done in the 2018 spray block which forms the west-most section of the Eastern Tsetse Belt. It is envisaged to work at accessing the necessary support towards further assessment/evaluation of the other sections of the Eastern Tsetse Belt, as the next area of focus with regard to the implementation of the PATTEC agenda in the country, so as to assess/analyse the available options with regard to prospects and choices for systematic elimination of the flies from the belt. Ultimately, it is intended to embark on a process that could lead to gradual and systematic elimination of tsetse flies from the whole of the eastern tsetse belt in the country, in the context of the PATTEC agenda.

RAPPORT SUR L'ETAT D'AVANCEMENT DES ACTIVITÉS DE LUTTE CONTRE LA MOUCHE TSE-TSE ET LA TRYPANOAMIASIS EN TANZANIE : 2015 À 2017

PROGRESS REPORT ON TSETSE AND TRYPANOAMIASIS ACTIVITIES IN TANZANIA FROM 2015 TO 2017

Joyce Daffa

Résumé

Les trypanosomiases humaine et animale africaines transmises par la mouche tsé-tsé sont des zoonoses d'importance socioéconomique et leur endiguement est essentiel à la sécurité alimentaire en Tanzanie. Ces maladies mettent en danger près de 4 millions de personnes dans 6 régions et 17 millions de bovins et autres espèces animales dans une trentaine de régions dans les écosystèmes de l'interface homme-animal. Au cours de la période considérée (2015 - 2017), les rapports ont révélé qu'il y a <10 nouveaux cas de trypanosomiase humaine africaine à rhodesiense (RHAT) chaque année. Près de 3851 cas de trypanosomiase animale africaine (TAA) et 317 décès dans 29 foyers dans 66 districts (2016) appartenant à 20 régions ont été signalés par les agents de surveillance.Les agents pathogènes fréquents pour le bétail sont Trypanosoma vivax, T.congolense et T. brucei qui affectent également les chevaux, les ânes et les chèvres, tandis que T. simiae affecte les porcs. Compte tenu du fait que la chaîne alimentaire humaine est constamment menacée par les zoonses endémiques ainsi que par les maladies émergentes et réémergentes, les ministères responsables de la santé, de l'élevage et de la faune, en collaboration avec la FAO et l'Unité de coordination de l'approche « Une seule santé » (OHCU), ont identifié 6 maladies zoonotiques prioritaires (PZD), parmi lesquelles figure la THA. Le contrôle de la mouche tsé-tsé et de la trypanosomiase (T & Tc) est en cours dans les parcs nationaux et les régions touchées. De plus, des matériels de sensibilisation et des directives de surveillance ont été développés pour le T & Tc. En ce qui concerne la recherche, les activités en cours (pour n'en citer que quelques-unes) comprennent : l'amélioration de la réaction réfractaire des vecteurs à l'infection à trypanosome ; l'évaluation des trypanosomes infectieux humains dans les parcs nationaux et de la capacité du système de santé pour la gestion durable de la THA. Cet article met en relief les activités progressives sur les T & T en Tanzanie.

Abstract

Tsetse transmitted Human and Animal African Trypanosomiasis are zoonotic diseases of socio-economic importance and its containment is crucial towards

food security in Tanzania. These diseases put at risk about 4 million people in 6 regions and 17million cattle and other livestock species in about 30 regions in human-animal interface ecosystems. During the period under review (2015 to 2017) the reports showed that there is <10 new rhodesiense Human African Trypanosomiasis (rHAT) cases annually. About 3851 Animal African Trypanosomiasis (AAT) cases and 317 deaths from 29 foci in 66 districts (2016) from 20 regions reported from surveillance. Common cattle pathogens are Trypanosoma vivax, T.congolense and T. brucei which also affect horses, donkeys and goats; whereas T. simiae affect pigs. In cognition that the human food chain is continuously threatened by endemic as well as emerging and re-emerging zoonotic diseases; currently, the lead ministries for Health, livestock and Wildlife in collaboration with FAO and One Health Coordination Unit (OHCU) identified 6 Priority Zoonotic Diseases (PZDs), among them is

HAT. Tsetse and Trypanosomiasis control (T&Tc) is on - going in National parks and affected regions. Moreover, advocacy materials and surveillance guidelines have been developed for T&Tc. On research, the on-going activities to mention a few include enhancing vector refractoriness to trypanosome infection; assessing human infective Trypanosomes in National Parks and capacity of health system for sustainable management of HAT. This paper highlights on progressive T&T activities in Tanzania.

Introduction

Tanzania has a total area of 945,000 sq. km with human population approximately 50.76 million. It is endowed with abundant Livestock population approximated about cattle 28.55 million, goats 16.67 million, sheep 5.01 million, pigs 1.85 million and donkeys 572,357. Over 80 % of the population living in rural areas is heavily dependent on agriculture i.e. crop, livestock, fisheries and forestry, which accounts for nearly a half of the national income. The African Trypanosomiasis (AT) is a hindrance to rural development as it limits land use, threatens Tourism industry, human health and Livestock development.

Tsetse transmitted African Trypanosomiasis (AT) is a zoonotic disease of Medical, Veterinary and Socio-economic importance and its containment is vital towards food security in Tanzania. These diseases put at risk about 4million people in 6 regions and 17million cattle and other livestock species in about 30 regions in human-animal interface ecosystems.

Animal African Trypanosomiasis (AAT) is an endemic livestock disease widely occurring and affecting different types of animal such as cattle, donkeys, horses, goats and pigs. AAT caused loss due to mortality, abortions, and long inter-calving rates and reduced milk yield has been estimated at US$ 7.98 million annually.

Tsetse and Transmitted African Trypanosomiasis Activities in 2016-17

The Rhodesiense Human African Trypanosomiasis (rHAT)type) is endemic and localized in Western and Northern regions in Tanzania (Map 1). Usually, risk is most prevalent in western regions of Kigoma, Rukwa, Katavi, and Tabora and in the northern regions of Arusha, Manyara and Mara. During the period under review (2016 to 2017) surveillance reports showed that there is a decrease in number of HAT cases in years from 55 in 2008 to 3 in 2010 and 2 in 2017 i.e. <10 new cases reported annually. However, it is so challenging because Interventions and funding decreases with low case.

On the other side, surveyed data indicated that 32.8% of 945,087 sq km of Tanzania is infested by 7 tsetse species in a fragmented pattern with high challenge in conservation areas (Map.2). There are seven (7) Glossina species namely, G. morsitans, G. swynnertoni, G. longipennis, G. brevipalpis, G. pallidipes, G. fuscipes and G. austeni.

Bovine AAT is widely distributed with prevalence more than 15% from field surveys results. The common recorded cattle pathogens are Trypanosoma vivax, T. congolense and T. brucei which affect, donkeys and goats; whereas T. simiae for pigs The trend of regions in 2016 reported annual average of 3851 Bovine cases and 317 deaths from 29 foci in 73 districts of 21 regions and in 2017 May average bovine cases was 823 and 49 deaths reported from 10 foci in 39 districts in 17 regions (Maps 3 and 4). Usually, disease, reports showed more bovine cases than those of the other types; but early 2017 the Zonal Investigation Centers (ZVCs) in central and southern Tanzania reported a rising number of trypanosomiasis cases in donkeys goats and dogs. In contrast to bovine trypanosomiasis that has clear signs these other animal types in most situations the infection does not manifest overt clinical signs and therefore go unnoticed. Still, AAT underestimation is common due to undiagnosed and unreported cases.. Moreover, at farm level AAT as animal health risk have low cognition / perception and rank low compared to other vector borne diseases such as Theileriosis - East Coast Fever (ECF) therefore a need for a different dimension of advocacy. Yet at farm level Tsetse and Trypanosomiasis Control (T&Tc) continued to been undertaken through integrated management of Insecticide Treated Targets (ITT) and use of subsidized pyrethroids insecticides for dipping and spraying cattle (ITC). These T&Tc activities were supervised by Veterinary staff from the Central and Local government Authority (LGA). Moreover, T&Tc constantly continued in the National parks and game reserves. At all levels T&TC constantly challenged by inadequate fund release for undertaking effective field interventions. Public Private Partnership (PPP) is advocated for sustainable intervention.

Human African Trypanosomiasis (HAT)

In cognition that the human food chain is continuously threatened by endemic as well as emerging and re-emerging zoonotic diseases; currently, the lead ministries for Health, livestock and Wildlife in collaboration with FAO Country Office and One Health Coordination Unit (OHCU) identified 6 Priority Zoonotic Diseases (PZDs), among them is AT. Guideline has been formulated together with multi-sectoral Technical Working groups (TWG) for Surveillance, Advocacy and Policy have been formed for better prevention, detection and response under One Health. Moreover, due to long distances to Health facilities and limited capacities of some Health facilities to diagnosis and treat HAT, the Ministry responsible for Health conducted inventory of health facility system capacity for sustainable management of HAT. In addition, advocacy materials and surveillance guidelines have been developed and distributed for T&Tc.

Research and Training

The FAO National Office in June 2017 facilitated a capacity building training for the Department of Veterinary Services (DVS) staff on spatial epidemiology, spatial regression modelling and predictive mapping for AAT and other diseases risk assessment in Zanzibar in support of Global Health Security Agenda. Other training was for the multi sectoral technical working groups on diseases Rapid Response Teams, Emergency Health Risk Communication & Rumour response for building trust and community participation in disease control.

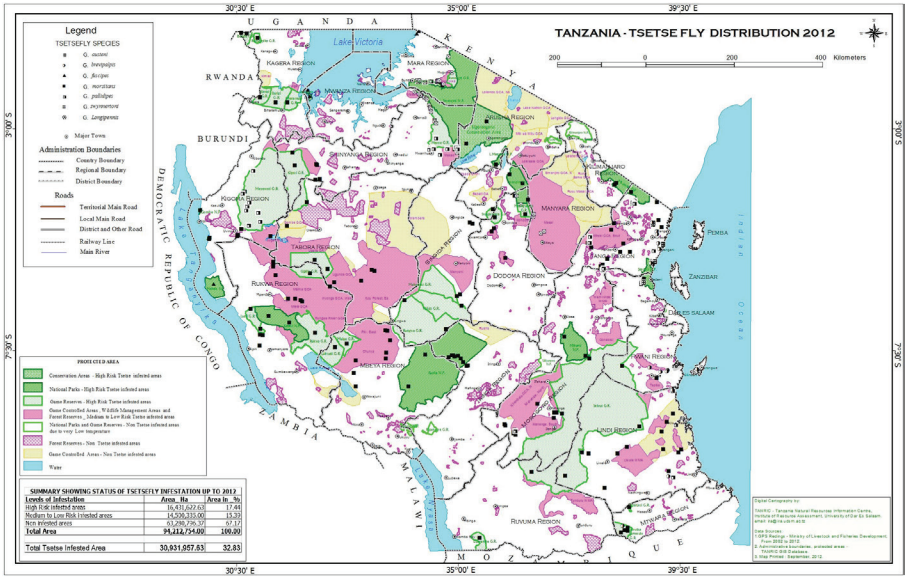
The on-going research activities at the Vector and Vector-borne Disease Control Center (VVBDC) Tanga; to mention a few include Enhancing vector refractoriness to trypanosome infection; Assessing Epidemiological Roles of Wildlife and livestock in AT transmission , and human infective Trypanosomes in National Parks.

The Future Plans

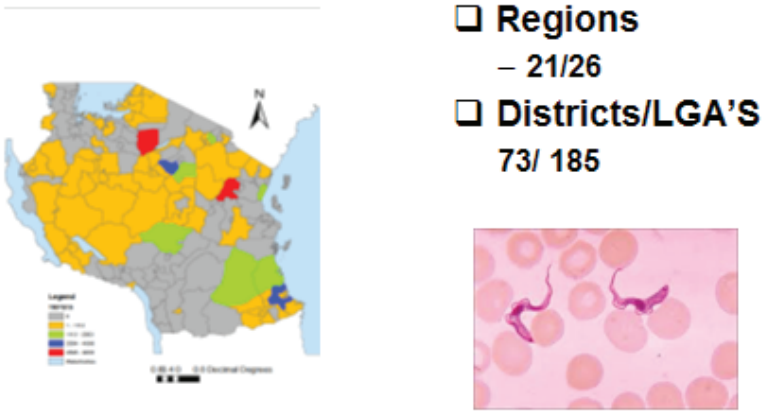
The government will collaborate with other stakeholders for Advocacy and Capacity building, Surveillance, Research and Control. Some of the foreseen activities in the near future are to review the T&TC Strategic plan 2013-17 and determine the G. swynnertoni limits for future eradication in collaboration with International Atomic Energy Agency (IAEA). Last but not least to mobilize human and finance resources for T&T programs.



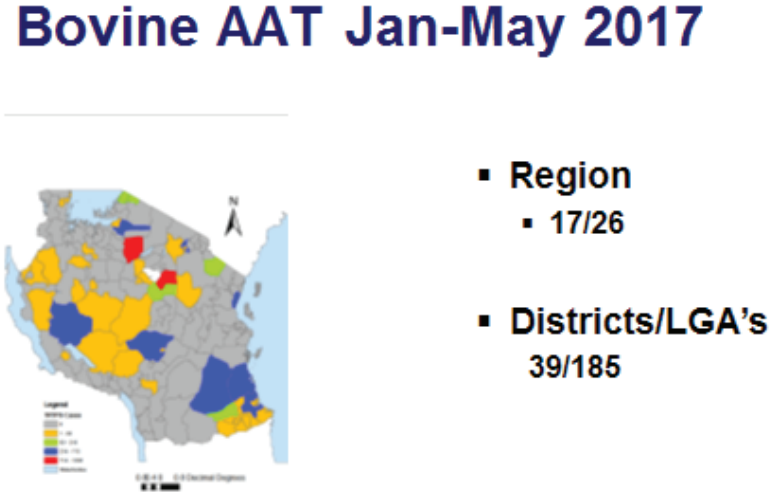
Map 1:*Human African Trypanosomiasis Endemic Regions -Tanzania*



Map 2: *Tsetse distribution in Tanzania – 2012*



Map 3: *Districts and Regions reporting Animal African Trypanosomiasis (AAT) in 2016*



Map 4: *Districts and Regions reporting AAT in 2017*

RAPPORT NATIONAL SUR LA SITUATION DE LA LUTTE CONTRE LA MOUCHE TSE-TSE ET LA TRYPANOSOMIASE AU SOUDAN DU SUD

COUNTRY REPORT ON THE CONTROL STATUS OF TSETSE AND TRYPANOSOMIASIS IN SOUTH SUDAN

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Résumé

La mouche tsé-tsé et la trypanosomiase (T & T) constituent un obstacle au développement socioéconomique des habitants démunis des zones rurales du Soudan du Sud. Ce rapport met en évidence l'état de contrôle des T & T dans le pays. Les données pertinentes des ministères de la Santé, de l'Elevage et de la Pêche ont été recueillies. L'analyse PESTEL a été intégrée pour révéler l'impact des facteurs politiques, économiques, sociaux, technologiques, environnementaux et juridiques sur les progrès réalisés dans le contrôle des T & T dans le Soudan du Sud. Les cas liés à la trypanosomiase humaine africaine (THA) ont été établis à 968 dans la période 2010 - 2014 et seulement 17 en 2015, mais le nombre de nouveaux cas indiqué de juillet 2016 à 2017 est une sous-estimation en raison des situations d'insécurité. 15% de la population bovine souffrant de trypanosomiase animale africaine (TAA) a développé une résistance aux trypanocides couramment utilisés dans l'ancien État de Bahr el Ghazal, comparativement à un taux inférieur à 5% dans les neuf autres États. Glossina f. fuscipes et G.m.submorsitans sont des mouches tsé-tsé vectorielles potentielles. La densité apparente des mouches / piège / jour a augmenté dans les zones infestées. Cela s'explique principalement par le caractère médiocre et l'aspect délabré des établissements sanitaires et vétérinaires attribuables à l'instabilité politique, aux turbulences économiques, aux troubles sociaux, aux bouleversements technologiques, aux changements environnementaux et aux facteurs juridiques. Les efforts déployés par l'OMS, la FAO et FIND / Maltese International pour le contrôle de la trypanosomose dans les zones rurales affectées sont appréciés. Les T & T entraînent un bouleversement des objectifs de développement durable (ODD). Les partenaires au développement sont invités à renforcer la voie du contrôle progressif (PCP) de la TAA et l'inclusion de la mouche tsé-tsé dans la stratégie de contrôle de la THA dans le Soudan du Sud.

Mots-clés : tsé-tsé, trypanosomiase, contrôle, Soudan du Sud

Abstract

Tsetse and Trypanosomiasis (T&T) cause an impediment to socioeconomic development among the poor rural inhabitants in South Sudan. This report highlights on the control status of T&T in the country. Relevant data from the Ministries of Health and of Livestock and Fisheries, and review papers were collected. PESTEL analysis was incorporated to reveal the impact of political, economic, social, technological, environmental and legal factors on the progress made in the control of T&T in South Sudan.Cases due to human African trypanosomiasis (HAT) were 968 in 2010 – 2014 and only 17 in 2015 but new cases from July 2016 to 2017 are underestimated due to insecurity situations. 15% of cattle population suffering from animal African trypanosomiasis (AAT) developed resistance to the commonly used trypanocides in the former Western Bahr el Ghazal State compared to less than 5% in other nine States. Glossina f. fuscipes and G.m.submorsitans are potential vector tsetse flies. The apparent density of the fly / trap / day increased in the infested areas. This is mainly due to poor and dilapidated health and veterinary facilities attributing from political instability, economic turmoil, social unrest, technological upheaval, environmental change and legal factor. Efforts being made by WHO, FAO and FIND/Maltese International for the control of typanosomiasis in the affected rural areas are appreciated. T&T create an upheaval to sustainable development goals (SDGs). Development partners are urged to strengthen the progressive controlpath way (PCP) of AAT and inclusion of tsetse in the control strategy of HAT in South Sudan.

Keywords: Tsetse, Trypanosomiasis, Control, South Sudan

1.0 Introduction:

South Sudan is endowed with vast natural resources including 11.8 million heads of cattle and 26.6 million sheep and goats compared to human population of 12.5 million (UNDP,2012). However, African trypanosomosis is one of the priority diseases both in livestock and human. Tsetse and Trypanosomiasis (T&T) cause an impediment to socioeconomic development among the poor rural inhabitants in a-250, 000 km2 tsetse infested area accounting for approximately 38.5% of the total country' territory.

Seven species and subspecies of tsetse are distributed across the country except in the Wet Sudd region and the plain flooded zones of the former Unity, Lakes and Jonglei States. These flies include Glossina morsitans submorsitans, G.pallidepis, G. fuscipes fuscipes , G. tachinoides, G.fusca

fusca , G.longipennis and G.fuscipleuris (Snow,1984). However, G f fuscipes and G.m. submorsitans are incriminated as the principal vectors of Gambian Human African Trypanosomiasis (HAT), commonly known as sleeping sickness in man and Animal African Trypanosomiasis (AAT) or Nagana in cattle, respectively. Moreover, G. fuscipes population was reported to provide insights for HAT in the neighbouring Uganda (Aksoy et al., 2013). The distribution of tsetse flies is most influenced by spatial factors including climate, vegetation and land utilization (Lukaw et al., 2014).

Apparently, understanding the population dynamics of both livestock and human is very crucial for developing strategies for vector control (Hay et al., 1998). Elimination of HAT and AAT remains unresolved in the light of the prevailing situation which faces the country. Seemingly, the development of a progressive control pathway (PCP) for AAT (Diall et al., 2017) and application of the integrated strategy for HAT control (FIND and Malteser International, 2016) are promising.

This paper highlights on the control status of T&T in South Sudan which could provide an impetus for the key stakeholders and development partner to intervene in due time such that such a disease scourge facing livestock and human are addressed for maximization of land use and achievement of sustainable development goals(SDGs).

2.0 Materials and Methods:

Tsetse field survey deploying 50 unbaited biconical traps were made, once per annum in both dry and wet seasons. Flies caught were counted, segregated into sexes and the apparent densities of flies /trap/day was determined (Dede et al., 2005). Ground spraying and pour-on were employed for tsetse on the environment and cattle and environmental impact assessment (EIA) was made. Moreover, Ethidium bromide tablets were provided to cattle as the commonly used trypanocidal drugs.

Cases of HAT effective from 2010 -2015 were collected and collated as secondary data from Ministry of Health (MoH). New cases as of July 2016 to 2017 were underestimated due to insecurity situations. Reports on annual livestock diseases were consulted to support the current trend of disease control (MLFD, 2015). Political, economic, social, technological, environmental and legal (PESTEL) implications on the control of T&T were also analyzed to justify the current control status in South Sudan.

Data were analyzed using Statistical Packages for Social Sciences (SPSS) version 21 and $p < 0.5$ at significant differences was taken into account.

3.0 Results and Discussions:

So far the areas under control activities covered was approximately130,000 km2 and the surveyed area could reach 113,000 km2.Number of male fly catches was significantly higher ($p<0.05$) than that of females which is in line with the report of Okoh et al. (2011) which revealed that male flies had immediate response to static objects and traps. Usually, female fly catches are higher in any season which could be explained by the natural longevity of females to cope with reproductive efficiency and production of much more larvae for biotic survival of the flies. The apparent densities of flies /trap/day increased to 3 as opposed to reduction from 5 to 1.3 in 2015/2016 which was due to irregular control campaigns. Due to insecurity and other unforeseen reasons the area under pour-on activities was only 5,000 Km2 in Kajo-Keji County (figure 1). Ethidium bromide and Novidium chloride tablets were heavily used for treatment of AAT mostly in the former Northern Bahr El-Ghazal State. In which it was reported that 15% of cattle population suffered from AAT had developed resistance to the commonly used trypanocides in the former Western Bahr el Ghazal State compared to less than 5% in the other former nine States. Trypanocidal drug resistance is occasionally reported in some African countries including Kenya (Mugunieri et al., 2003) and Zambia (Sinyangwe et al., 2004).This could be related to mutation as a result of repeated under dosage practiced by a number of farmers/pastoralists. Moreover, Deltamethrin was sprayed as insecticide in an area of 10,000 Km^2, but no detailed records on EIA were expressed.

HAT cases were reported to be 968 as of 2010-2014 and only 17 cases recorded in 2015 but new cases as of July 2016 to 2017 are underestimated due to insecurity. This alarming increase in the cases of HAT could be explained by severe reduction in health facilities and inaccessibility attributing to the current civil unrest. PESTEL analysis revealed that prospects for the control of T&T in the light of the prevailing situation are at stake. Nevertheless, this does not necessarily mean that the current HAT surveillance and screening activities carried out by Malteser International across Yei River, Maridi and Magwi Counties are underrated.

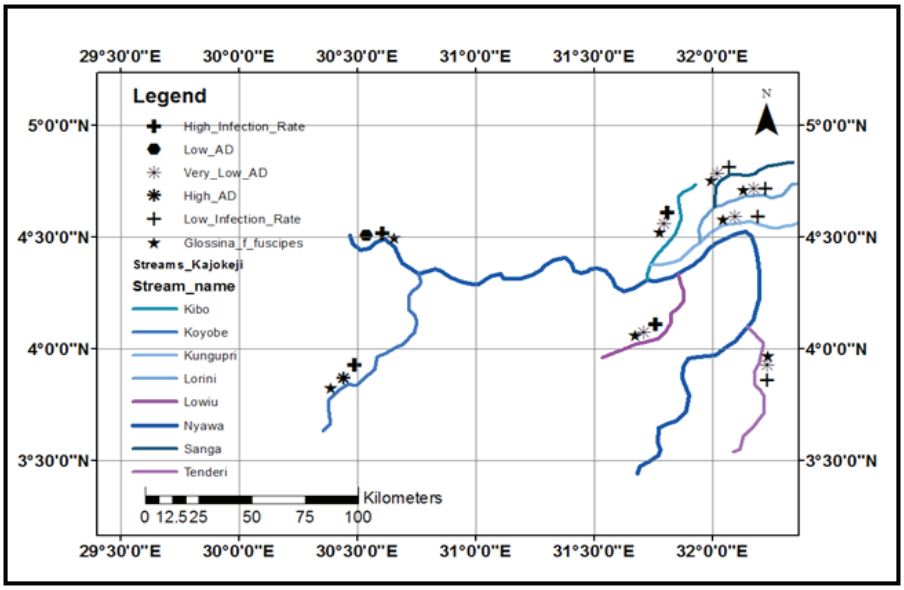


Figure (1): *Kajokeji County showing the main streams and degree of infection rate and apparent density/flies/day due to G.f.fuscipes. Source: Yatta S. Lukaw, PhD. Thesis, 2016 University of Juba.*

4.0 Conclusion and the Way Forward

Control status of T&T remains erratic but promising in the mid-and long run should the planned activities (Table 1) be taken into considerations. Efforts being made by WHO, FAO and FIND/Malteser International for the control of typanosomiasis in the affected rural areas are encouraging.T&T create an upheaval to achievement of SDGs. Key stakeholders and development partners are urged to strengthen the PCP tools for AAT elimination and prioritize the inclusion of tsetse in the control strategy of HAT in South Sudan.

Table (1): *Planned activities and expected results for T&T control, 2018 in South Sudan.*

Activities	Expected Results	Tentative budget	Source of fund
Training and capacity building	• Trained staff increased in numbers. • Skills needed to enhance innovations for T&T control provided.	US $ 75,000	WHO, FAO,UNDP, Development partners, and GoSS

Activities	Expected Results	Tentative budget	Source of fund
Xenomonitoring of T.b.gambiense /T.b.rhodesiense in Akobo County, JS and Magwi, EES in Tsetse	T.b .gambiense HAT confirmed /T.b .rhodesiense in Magwi and Akobo Counties detected ?	US$ 50,000	WHO and Development partners, and GoSS
Tsetse control	• Apparent densities of flies per day reduced . • Land use optimized • Livelihoods of poor rural population improved	US $ 100,000	WHO,FAO , Development partners, and GoSS
HAT control	• Prevalence of HAT in endemic areas reduced. • Sustainable development goals (SDGs) achieved.	US$ 150,000	WHO , Development partners, and GoSS

Acknowledgements:

We are grateful to acknowledge AU/IBAR and AU/PATTEC coordination office for co-organizing such a successful ISCTRC conference. All International donors and key stakeholders are indebted for their pivotal role to see into it that T&T will become a history in African continent.

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RAPPORT SUR LES ACTIVITÉS DE CONTRÔLE DE LA MOUCHE TSÉ-TSÉ ET DE LA TRYPANOSOMOSE

REPORT ON TSETSE AND TRYPANOSOMOSIS CONTROL ACTIVITIES

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Résumé

Introduction : L'infestation de mouches tsé-tsé couvre moins de 4% de la surface totale du pays, et les zones affectées comprennent deux endroits qui se trouvent dans les grandes routes migratoires. D'autres mouches piqueuses sont présentes dans la grande partie du pays.

Informations générales : Objectifs : Renforcer la sécurité alimentaire et atténuer la pauvreté rurale par le contrôle de la mouche tsé-tsé et la valorisation de nouvelles terres pour l'élevage et la production végétale, ce qui, en outre, pourrait minimiser les frictions et conflits tribaux au sujet des terres.

Composantes : Formation à tous les niveaux (personnel technique et membres des communautés) / Enquêtes sur le terrain utilisant des méthodes qualitatives et quantitatives / Études de recherche axées sur les parasites et vecteurs / Besoins de contrôle des mouches / enquêtes socioéconomiques pour évaluer les implications de la mouche tsé-tsé et de la trypanosomose / Evaluation environnementale / Vulgarisation et sensibilisation du public au sein des communautés rurales.

Activités principales : Identification des participants / Approvisionnement en matériel de laboratoire, matériel de piégeage, réactifs, fournitures et véhicules / Achat de médicaments vétérinaires, insecticides et vaccins / Conception de questionnaires pour générer des informations pertinentes / Plaidoyer et soutien.

Activités en cours

a. **Ceinture de la Rivière Yabus :** Activités suspendues à cause de l'insécurité.
b. **Ceinture Radom :** 3000 têtes de bétail additionnels traités avec des formulations pour-on.
c. **Trypanosomose transmise par des vecteurs autres que la mouche tsé-tsé :** le taux de la prévalence globale était de 6,5% dans les nouvelles zones soumises aux investigations.
d. **Approches communautaires :** L'intégration des communautés locales des zones affectées par la mouche tsé-tsé dans les programmes de contrôle et l'évaluation de l'impact socio-économique de la maladie est en cours.

Défis : Insécurité/ Durabilité des fonds publics / Recrutement de nouveau personnel technique.

Moyens d'accomplir des progrès : Aborder les problèmes de résistance aux médicaments / Options pour le contrôle de la trypanosomose causée par des vecteurs autres que la mouche tsé-tsé / Discussion des accords bilatéraux / étude de l'impact sur l'environnement.

Abstract

Introduction: Tsetse flies infest less than 4% of the total surface area of the country and affected areas include two locations which fall within major migratory routes. Other biting flies occur throughout most of the country.

Objectives: To enhance food security and alleviate rural poverty through controlling tsetse and reclaiming new land for livestock and crop production which, additionally, could minimize tribal frictions and conflicts over land.

Components: Training at all levels (technical staff and community members)/ Field surveys using qualitative and quantitative methods/ Research studies directed at the parasite and vector/ Fly control requirements/ Socio-economic surveys to assess the implications of tsetse and Trypanosomosis/ Environmental assessment/ Extension and public awareness among rural communities.

Main activities: Identification of participants/Procurement of laboratory

equipment, trapping material, reagents, supplies and vehicles/Purchase of veterinary drugs, insecticides and vaccines/Questionnaire design to generate relevant information/Advocacy and support.

Current activities:

a. **River Yabus belt:** Activities suspended due to insecurity.
b. **Radom belt:** Additional 3000 heads of cattle treated with pour-on formulations.
c. **Non-tsetse transmitted Trypanosomosis:** Overall prevalence was 6.5% with new areas investigated.
d. **Community-based approaches:** Local communities in tsetse-affected areas incorporated in control programmes and assessment of socioeconomic impact of the disease is underway.

Challenges: Insecurity/ Sustained governmental funds/ Recruitment of fresh technical staff.

Way Forward: Addressing drug resistance issues/ Options for control of non-tsetse transmitted Trypanosomosis/ Discussion of bilateral agreements/ Environmental impact study.

Introduction:

The livestock sub-sector in the Sudan constitutes the largest sub-sector of the economy which employs about 14% of the population, predominantly pastoralists, who own about 80% of the national herd which mounts up to 105 million and contributes to about 20% of Gross Domestic Product (GDP). Trypanosomosis is recognized as one of the greatest constraints to socioeconomic development in the Sudan, hampering the full utilization of a large part of this wealth. The tsetse flies occupy an area of about 50 000 km2, 40 000 km2 lay within Radom locality, South Darfur State extending into Republic of South Sudan. In the rainy season animals serve as sources of infection in other areas through the aid of biting flies. The other 10 000 km2 extend from Kurmuk locality to localities south of River Yabus, Blue Nile State. These migratory herds are the source of trypanosomosis infection to all cattle kept outside the tsetse fly zone. It was also noticed that all the available trypanocidals exhibit a degree of inefficiency against the disease in this area. Recommended control methods are traps, insecticide-impregnated targets and insecticide-baited cattle, which are all environmentally friendly methods, in addition to the sterile insect technique (SIT) as a final option. Part of the base-line data which included tsetse surveys, mapping, animal

Trypanosomosis surveys, socio-economic studies and environmental surveys, was collected during an FAO TC project conducted in this area during the period 2001/2002, which was followed by the assigning of a Pan African Tsetse and Trypanosomosis Eradication Campaign (PATTEC) focal point who supervised recent activities which were executed within IAEA TC projects to update former base-line data in the past three years.

A bilateral agreement between the Republic of Sudan and the Federal Republic of Ethiopia was signed with the purpose of combining efforts of tsetse intervention in the border areas of the two countries. The neighbouring Governorates of the two countries agreed to formulate joint teams to help in tsetse control of their common fly belts. This activity was encouraged by the African Union, as part of the PATTEC initiative. Similar agreements will be presented for approval by other neighbouring countries (Republic of South Sudan and The Central African Republic).

General information:

- **Objectives:** To enhance food security and reduce rural poverty through controlling tsetse and regaining arable land for livestock and crop production, additionally, to minimize tribal frictions and conflicts over land.
- **Components:** Training at all levels (technical staff and community members)/ Field surveys using qualitative and quantitative methods/ Research studies associated with the project/ Fly control requirements/ Socio-economic surveys to assess the implications of tsetse and trypanosomosis/ Extension and public awareness among rural communities.

Main activities:

- Identification of participants.
- Procurement of laboratory equipment, trapping material, reagents, supplies and vehicles.
- Purchase of veterinary drugs, insecticides and vaccines for collaborating animal owners.
- Questionnaire design to generate relevant information.
- Advocacy and support.

Current activities:

1- River Yabus Tsetse belt

Activities in Yabus area, Blue Nile State scheduled in this programme are a continuation of those started on April 2009 and included testing the efficiency of different trap and target designs and odour baits. Catching devices were deployed alongside river Yabus and Glossina fuscipes fuscipes and Glossina morsitans submorsitans were the only tsetse species encountered showing distinct distribution patterns, as reported in earlier studies.

Due to recently reported outbreaks of animal trypanosomosis with regard to the annual movement of nomads with their herds across the Sudan/Ethiopian border, a small scale control trial was planned and currently executed in the area involving insecticide-impregnated targets and biconical traps deployed on both sides of the river up to 10 km. Results revealed a reduction in the tsetse population by 99.83%. Activities are currently suspended in the area because of security issues.

2- Radom Tsetse belt:

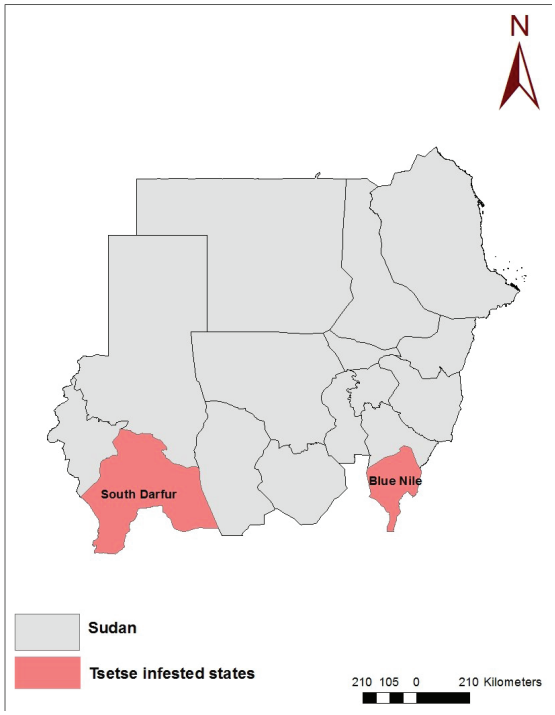
Baseline data on the tsetse population dynamics in Radom area, South Darfur was provided through extensive surveys and results showed the existence of a single species, Glossina morsitans submorsitans.

Pour-on formulations were applied to create a fly-free area. Initially 5600 heads of cattle were treated and a 98% drop in tsetse population was achieved. An additional 3000 heads of cattle were subjected to pour-on treatment. Regular entomological and parasitological surveys are currently conducted through locally based teams.

3- Non-tsetse transmitted Trypanosomosis:

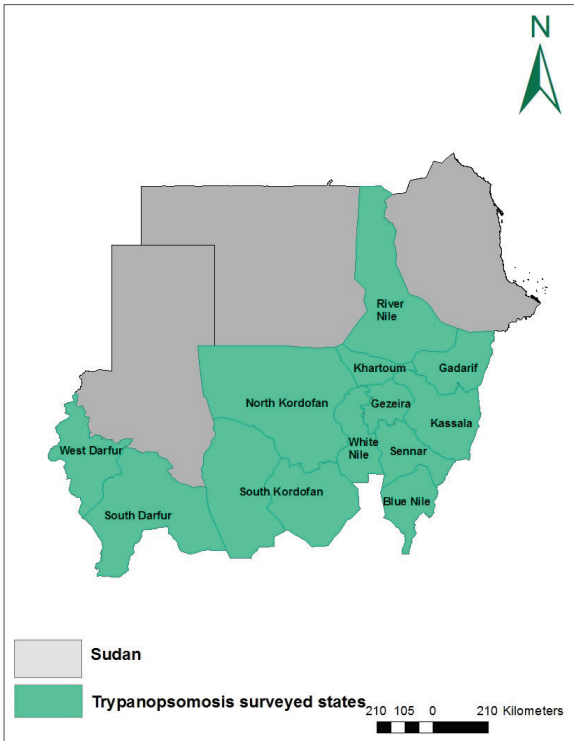
- *Bovine Trypanosomosis*

Geo-referenced parasitological and entomological surveys provided data indicating a shift in the incidence of animal trypanosomosis which coexisted with recently adopted husbandry practices aiming to boost the dairy production industry. The overall prevalence of cattle trypanosomosis in 11 states outside the tsetse area in Sudan was 6.5% attributed solely to Trypanosoma vivax, whereas in Khartoum State where most of the dairy schemes are based it reached up to 56%. Concurrent use of fly control measures (traps and zerofly nettings) and chemotherapy proved useful as the prevalence in Khartoum was brought down to 21%, nevertheless, drug resistance remains a concern to be addressed in future plans.





Major Migratory routes.



- Camel Trypanosomosis:

Surveys carried out in Gadarif state in Eastern Sudan targeting camel populations showed a prevalence of 39% due to Trypanosoma evansi infections using serological techniques (CATT). However, conventional methods (HCT) revealed only 19% of the infections casting the need to standardize diagnostic methods and formulating agreed protocols for diagnosis to be used in routine surveys.

4- Community-based approaches:

Three training workshops aiming to equip local communities in tsetse affected areas with the minimal knowledge and skills which would enable their integration in control programmes were carried out in collaboration with state governments. A total of 240 local representatives were engaged in TOT sessions demonstrating the construction, deployment and maintenance of fly catching devices among other relevant methods.

Socio-economic assessment of the impact of animal trypanosomosis on affected communities is underway using questionnaires, group discussions (rural appraisal), meetings with community leaders and observations as data collection methods.



Challenges:

- Insecurity remains as the major constraint.
- Sustained government funds. Partnerships with international agencies to support part of the project activities were pursued successfully.
- Recruitment of fresh technical staff.

Way forward:

- Addressing drug resistance issues.
- Exploring the options for control of non-tsetse transmitted trypanosomosis.
- Discussion of bilateral agreements regarding tsetse control programmes with neighboring countries sharing tsetse belts, i. e. South Sudan and CAR.
- Environmental impact study.

RAPPORT D'ÉTAPE SUR LE CONTRÔLE DE LA MOUCHE TSÉ-TSÉ ET DE LA TRYPANOSOMOSE AU GHANA

PROGRESS REPORT ON TSETSE AND TRYPANOSOMOSIS CONTROL IN GHANA

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Résumé

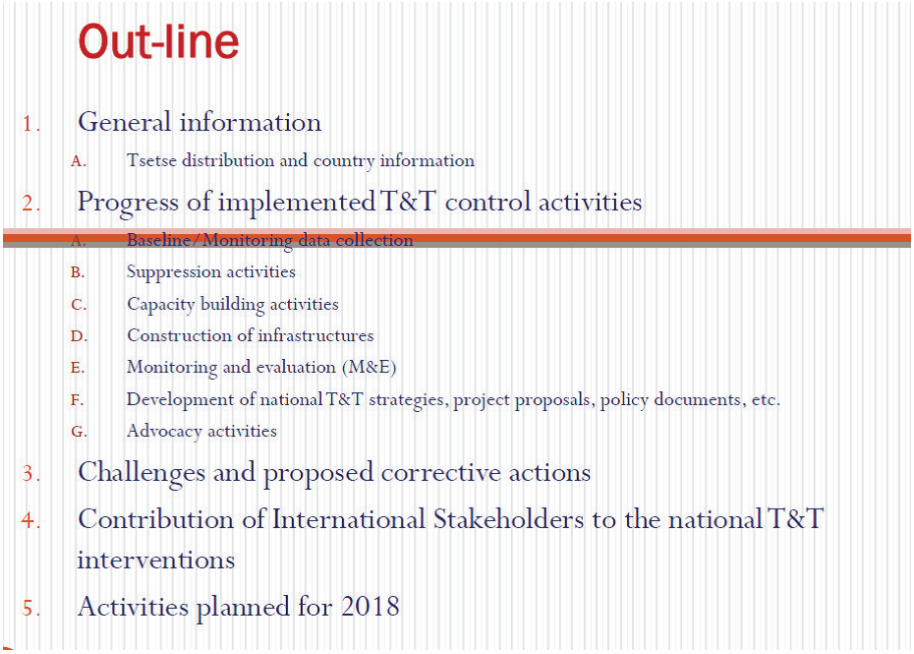
Environ 60% de la masse terrestre totale du Ghana est infestée de mouches tsé-tsé. Une intervention majeure dans le cadre de l'initiative AU-PATTEC a vu une réduction de 98% dans la zone infestée de tsé-tsé de l'UWR (Adam, Y. et al., 2013). Depuis 2011 jusqu'à ce jour, des activités continues de lutte contre la tsé-tsé et de surveillance ont été menées dans la région de l'Upper West du Ghana, sauf 2016. L'objectif de ces activités a été de prévenir la réinvasion des glossines et d'améliorer encore les gains de l'intervention principale de 2010. Les résultats de la surveillance de la densité apparente de la glossine 2015 n'étaient pas significativement différents de ceux de l'année 2011. Actuellement (juillet-août 2017), le personnel de l'unité de lutte contre la tsé-tsé exerce sur le terrain des activités sur le terrain, notamment: 1) Remplacement des barrières tsétsé brisées 2) Pulvérisation au sol et 3) surveillance de la dynamique des populations de mouche tsé-tsé dans l'UWR. Les résultats de ces enquêtes sont attendus pour mettre à jour notre état actuel. Le renforcement des capacités pour la mise en oeuvre d'interventions rentables dans la trypanosomose transmise par la tsé-tsé a été principalement motivé par deux projets de la FAO au Ghana (phase 1 GTFS / RAF / 474 / ITA et Phase 2 GCP / RAF / 502 / ITA). La FAO et le Cirad ont apporté leur soutien à l'analyse des données, ce qui a donné lieu à des publications scientifiques et à une thèse de doctorat sur les interventions tsé-tsé au Ghana (Adam Yahaya, 2014. Montpellier: UM2, 159 p. Thèse de doctorat). Les acteurs internationaux pour les programmes de lutte contre la tsé-tsé au Ghana sont: AU-PATTEC, FAO, CIRDES et CIRAD de France. Un plan d'activités pour les activités de lutte contre la tsé-tsé et la trypanosomose en 2018 a été élaboré et présenté au gouvernement du Ghana pour obtenir de l'aide.

Abstract

About 60% of Ghana's total land mass is infested by tsetse flies. A major

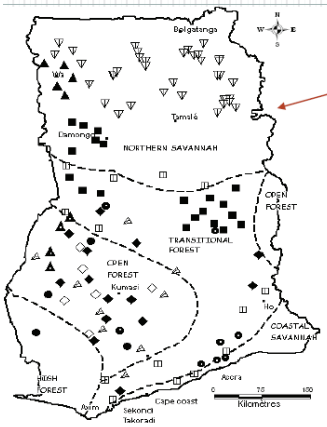
intervention under the AU-PATTEC initiative saw a 98% reduction in the tsetse infested area of the UWR (Adam, Y., et. al 2013). Since 2011 till date, a continuous tsetse suppression and monitoring activities have been on going in the Upper West Region of Ghana, save 2016. The objective of these activities have been to prevent tsetse reinvasion and to further improve gains of the 2010 major intervention. Monitoring results of the 2015 tsetse apparent density were not significantly different from those of the year 2011. Currently (July-August 2017) staff of the tsetse control unit are on the field conducting field activities including: 1) Replacement of broken down tsetse barriers 2) Ground spraying and 3) monitoring tsetse population dynamics in the UWR. Results of these surveys are being awaited to further update our current status. Capacity Building for the implementation of cost-effective interventions in tsetse transmitted trypanosomosis have been mainly driven by two FAO projects in Ghana (Phase1 GTFS/RAF/474/ITA and Phase2 GCP/RAF/502/ ITA). FAO and

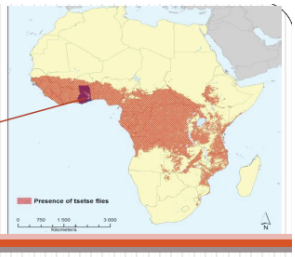
CIRAD gave support for Data Analysis resulting in scientific publications and defence of PhD dissertation on tsetse interventions in Ghana (Adam Yahaya. 2014. Montpellier : UM2, 159 p. Thèse de doctorat). International stakeholders for tsetse control programmes in Ghana include: AUPATTEC, FAO, CIRDES and CIRAD of France. A plan of activities for tsetse and trypanosomosis control activities in 2018 has been drawn up and presented to the Government of Ghana for support.



General information 2/2

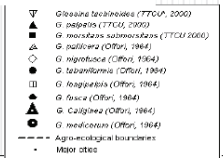
TSETSE DISTRIBUTION IN GHANA





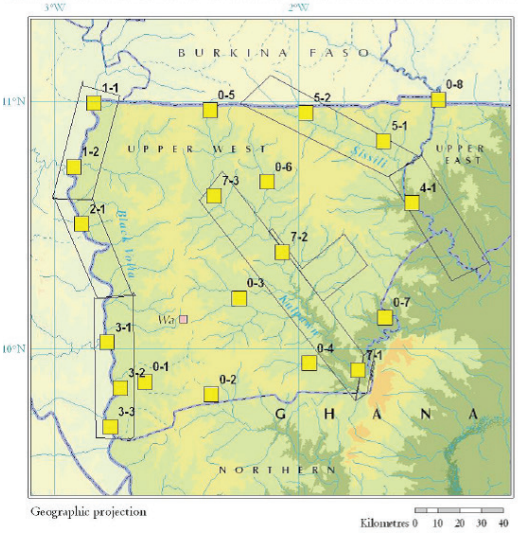
- Area infested by Tsetse: About 60% of 238,500km^2
- Area under control activities: 18,000 km^2
- Human population: 25, 199, 601 (2013)
- Cattle population : 1,527,022 (estimated)
- Most important livestock diseases in Gana ranked in order of importance:

AAT, FMD, CBPP → ASF, Brucellosis, Tuberculosis → Rabies, Mange, NCD



3

Progress of T&T control activities 1/5

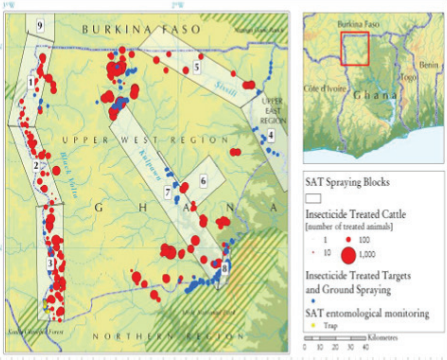


Baseline/Monitoring data collection

- Size of surveyed area: 18,000 km^2
- Continuous tsetse suppression by annually replacing broken down tsetse barriers (Targets being legacies of the 2010 PATTEC Project in Ghana)
- Entomological surveys to measure suppression effort

Progress of T&T control activities 2/5

2010 control area



Control activities

- Pour-on:
  - ✓ Pour-on stock is depleted
  - ✓ Activities left to farmers since 2015-09
- Targets:
  - ✓ Currently staff of the Unit are on the field replacing broken down barriers)
- Ground spraying:
  - ✓ Currently staff of the Unit are on the field conducting ground spraying
- SAT:
  - ✓ No SAT application has been conducted since the last one in 2010
- SIT:
  - ✓ Ghana is yet to implement any SIT programme completely.
  - ✓ The Ghana Atomic Energy Commission under the support of PATTEC started a fly breeding project but run into problems.

5 7/25/2017

Progress of T&T control activities 3/5

Currently staff of the tsetse control unit are on the field conducting a number of field activities including:

1. Replacement of broken down tsetse barriers
2. Ground spraying at the southern tip of the UWR
3. Monitoring tsetse population dynamics
4. Creating awareness for farmers to take advantage of tsetse controlled areas gained from tsetse intervention campaigns in the UWR.

Progress of T&T control activities 5/5

Capacity Building for the implementation of cost-effective interventions in tsetse transmitted Trypanosomosis have been mainly driven by two FAO projects in Ghana (Phase1 GTFS/RAF/474/ITA and Phase2 GCP/RAF/502/ITA).

Beneficiary institutions in Ghana have been:

- Department of Veterinary Services
- Ministry of Health
- Ministry of Food & Agriculture
- Central Veterinary Laboratory

❖ The FAO and CIRAD gave support for Data Analysis resulting in scientific publications and defence of PhD dissertation on Tsetse control in Ghana (*AdamYahaya. 2014. Montpellier : UM2, 159 p. Thèse de doctorat*)

Progress of T&T control activities 5b/5

Advocacy activities

❖ Creating awareness for farmers to take advantage of tsetse-free lands gained from tsetse intervention campaigns in the UWR to improve their economic livelihoods.

❖ Encouraging the use of cost effective methods in livestock production and capacity building so as to improving food security and alleviating poverty among low income farmers

Construction/equipment of infrastructures

The existing infrastructure for tsetse and Trypanosomosis control in Ghana such as offices and equipment are adequate and no additional infrastructure is currently required.

9 7/25/2017

Challenges & Corrective Actions 1/1

Main Challenges/Constraints	Solutions against the challenge	Remarks
Funding control programmes is the biggest challenge	The AU-Commission should assume the lead role in whipping up governments desire	Local agencies engaged in implementing tsetse control programmes are civil servants with limitations in fund sourcing from gov.
Regional collaboration of T&T management is difficult because of varying levels of preparedness	There should be collaborative effort as well in fund sourcing	
Resource mobilization left to the implementing bodies	Resource mobilization should be triggered from the AU-Commission to participating governments	
Tsetse control can not be left to individual farmers because it's a public good.	There is the absolute need for governments to show absolute commitment	It is only the AU-Commission that can drum this policy direction to participating governments

International Stakeholders 1/1

Name of Partner/Stakeh	Description of Activities/Support provided	Remarks
FAO	**The FAO project GCP/RAF/502/ITA "Improving food security in sub-Saharan Africa by supporting the progressive reduction of tsetse-transmitted trypanosomosis in the framework of the NEPAD - Phase 2"**	**1. Providing technical assistance and on-the-job training in the development of a national Atlas of tsetse and African Animal Trypanosomosis (AAT) in Ghana 2.Provision of computers; GPS hand sets 3. Assistance Capacity building**
CIRAD	**CIRAD gave support for Data Analysis resulting in scientific publications and defence of PhD dissertation on Tsetse control in Ghana.**	
FAO	**FAO gave support for data analysis to three scientific publication**	
CIRDES laboratory	**CIRDES Laboratory provided for laboratory sample analysis leading to two scientific publications**	

Planned Activity for 2018	Expected Results	Tentative budget (GHs)	Source of Fund
Deployment of targets and barriers - Northern region	Tsetse population suppressed and tsetse re-invasion prevented	40,000.00	From Government's budgetary allocations
Grounds spraying of tsetse habitats in between barriers. NR	Tsetse re-invasion prevented tsetse population suppressed	30,000.00	From Government's budgetary allocations
Life baiting (Pour-on) in Kraals within 10km radius of Rivers in Upper East Region	Tsetse population suppressed	25,000.00	From Government's budgetary allocations
Chemotheraphy and chemoprophylaxis of livestock against trypanosomosis	Animal health improved. Increased livestock production	20,000.00	From Government's budgetary allocations
Deployment of bi-conical traps in selected tsetse habitats UER & NR	Baseline tsetse densities determined	30,000.00	Government's budgetary allocations

THE ACTIVITIES CARRIED OUT BY PATTEC-NIGER SINCE 2015
LES ACTIVITÉS RÉALISÉES PAR PATTEC-NIGER DEPUIS 2015

Moumouni Harouna

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Abstract

Niger is a Sahelian country with an essentially agro-pastoral vocation. Livestock occupies more than 87% of the population and contributes more than 11% to the national GDP and more than 25% of the household budget.

In order to promote better exploitation of animal potential, improve the health of its livestock and its level of production and valorization of productions, the Ministry of Agriculture and Livestock in the elaboration of the Sustainable Development Strategy, Livestock (SDD 2013 -2035). (li) the insignificance of both public and private investments in the sector; (i) the persistence of certain animal diseases; (ii) low productivity; and (iii) insignificance of both public and private investments in the sector. Sanitary constraints include tsetse flies and African Trypanosomoses(AAP). For all these reasons, Niger has opted to integrate itself in the realization of this continental objective of PATTEC to ensure the protection of its livestock against the tsetse fly and trypanosomiasis, today recognize as one of the causes Main economic backwardness and food industry on the continent. Within this framework, the Directorate General of Veterinary Services initiated the project to combat the tsetse fly and animal trypanosomiasis (PATTEC-Niger), which has the overall objective of achieving food security and the fight against poverty through a sustainable improvement of animal health.

Thus, from 2015 to date, PATTEC-NIGER has carried out the following activities:

1. Complementary entomological surveys;
2. Serological surveys on bovine trypanosomosis in Say Department to identify the three pathogenic trypanosome species;
3. Setting up and training of the epidemiological surveillance network;
4. Bovine treatments for trypanocides;

Résumé

Le Niger est un pays sahélien à vocation essentiellement agro-pastorale. L'élevage occupe plus de 87% de la population et contribue à plus de 11% dans la constitution du PIB nationale et à plus de 25 % du budget des ménages. Pour favoriser une meilleure exploitation du potentiel animal, améliorer la santé de son cheptel et son niveau de production et valoriser ses productions, le Ministère de l'Agriculture et de l'Elevage a élaboré une Stratégie de Développement Durable de l'Elevage (SDDE 2013-2035). Cependant, les principales contraintes qui handicapent le sous-secteur de l'élevage ont trait à (i) la persistance de certaines maladies animales, (ii) la faible productivité et (iii) l'insignifiance des investissements tant publics que privés dans le secteur. Parmi les contraintes sanitaires figurent la mouche tsé-tsé et les Trypanosomoses Animales Aficaines (TAA). Pour toutes ces raisons, le Niger a opté pour s'intégrer dans la réalisation de cet objectif continental de la PATTEC pour assurer la protection de son cheptel contre la mouche tsé-tsé et la trypanosomose, aujourd'hui reconnu comme l'une des causes principales du retard économique et de l'insécurité alimentaire sur le Continent. C'est dans ce cadre que la Direction Générale des Services Vétérinaires a initié le projet de lutte contre la mouche tsé-tsé et les tryponosomoses animales (PATTEC –Niger) qui a pour objectif global de contribuer à l'atteinte de la sécurité alimentaire et à la lutte contre la pauvreté à travers une amélioration durable de la santé animale.

C'est ainsi que de 2015 à ce jour, la PATTEC- NIGER a réalisé des activités suivantes :

1. les enquêtes entomologiques complémentaires ;
2. enquêtes sérologiques sur la trypanosomose bovine dans le département de Say pour identifier les trois espèces de trypanosomes pathogènes ;
3. mise en place et formation du réseau d'épidémiosurveillance ;
4. les traitements bovins aux trypanocides ;

1. **Dr Moumouni HAROUNA,** DVM, Msc en Epidémiologie, Expert en SIG, Direction Générale de Services Vétérinaires au Ministère de l'Agriculture et de l'Elevage – Niamey-Niger ;
2. **Pr Philippe KONE,** Maître de conférences Agrégé, Enseignent – chercheur à l'Ecole Inter- Etats des Sciences et Médecine Vétérinaire de Dakar
3. **Dr Hassane ADAKAL,** Chargé de cherches (DSTE) Maradi-Niger et Coordonnateur au Centre National de Spécialisation en Elevage PPAAO-Niger
4. **Dr Zakaria BENGALY,** Directeur Scientifique du Centre international de Recherche- Développement sur l'Elevage en zone Subhumide (CIRDES)

de Bobo-Dioulasso-Burkina Faso

5. **Dr Abdoulmalick HAIDO :** M.Sc Production Animale Tropicale, Directeur Général des Services Vétérinaires au Ministère de l'Agriculture et de l'Elevage – Niamey-Niger ;
6. **Bassirou SOULEY :** DVM, Msc en Santé Animale Tropicale, Chef Service Santé Animale à la Direction Régionale de l'Elevage de Tahoua -Niger ;

ERADICATION DE LA MOUCHE TSÉ-TSÉ (GLOSSINA PALPALIS GAMBIENSIS) DE LA ZONE DES NIAYES DU SÉNEGAL UTILISANT L'APPROCHE "AREA-WIDE INTEGRATED PEST MANAGEMENT" ET INCLUANT LESLÂCHERS DE MÂLES STÉRILES

THE ERADICATION OF THE TSETSE FLY GLOSSINA PALPALIS GAMBIENSIS FROM THE NIAYES OF SENEGAL USING AN AREA-WIDE INTEGRATED PEST MANAGEMENT APPROACH THAT INCLUDES THE RELEASE OF STERILE MALES

Baba SALL[1], Momar Talla SECK[2], Jérémy BOUYER[3] Marc VREYSEN[4]

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Abstract

The "Projet de lutte contre la mouche tsé-tsé et la trypanosomose dans les Niayes" targets a total area of 7,350 km2, of which 1,375 km2 were infested with Glossina palpalis gambiensis (Diptera: Glossinidae) which were solely responsible for the cyclical transmission of trypanosomes, the causative agents of African animal trypanosomosis (AAT). The tsetse population in the Niayes was completely isolated from the main tsetse belt in the south eastern part of the country, which prompted the Government of Senegal to select an eradication strategy of the vector and the disease, as the risk of re-invasion would be minimal or nonexisting. The project was implemented in different phases, i.e. following a phased conditional approach, which consisted of (1) training and commitment of all stakeholders, (2) baseline data collection (BLDC) and feasibility studies, (3) pre-operational activities, and (4) operational activities. An extensive entomological monitoring system implemented in the 3 operational blocks indicated the following: no wild fly catches since August 2012 in block 1, while in block 2 et 3 the densities of the wild tsetse populations have been reduced by > 99% at the time of writing. Monitoring data of sentinel herds located inside and outside the tsetse-infested area indicated already a significant reduction of the AAT prevalence. The

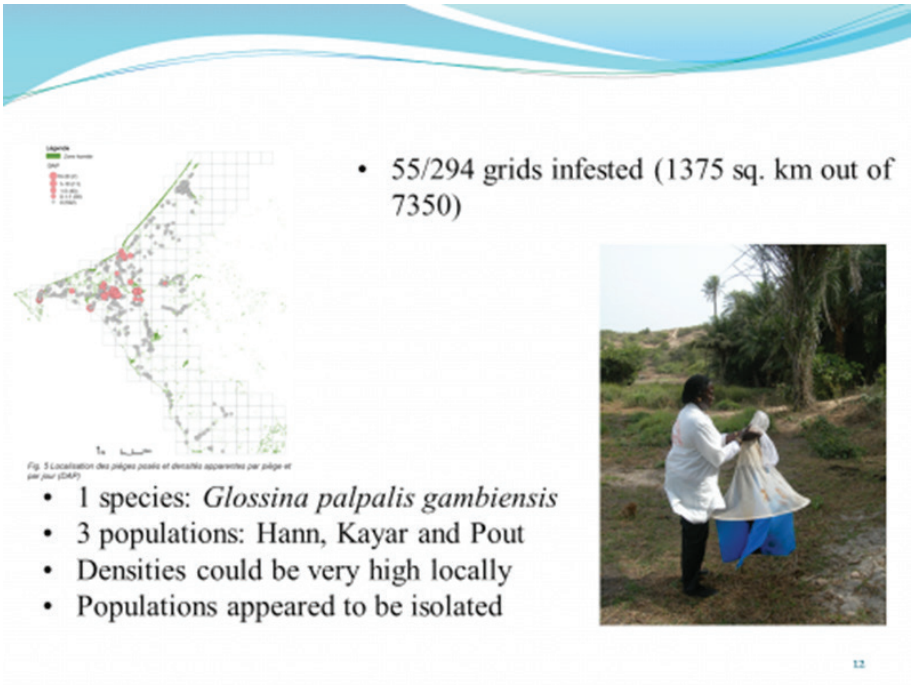
environmental monitoring demonstrated a very low impact of the project on non-target species, and the socio-economic

Résumé

Le "Projet de lutte contre la mouche tsé-tsé et la trypanosomose dans les Niayes" cible une superficie totale de 7,350 km2, dont 1,375 km2 infestés par Glossina palpalis gambiensis (Diptera : Glossinidae) responsables de la transmission cyclique de trypanosomes, agents causals de la Trrypanosomsoe Animal Africaine (TAA). La population tsé-tsé des Niayes est complètement isolée de celles de la zone Sud-est du pays la plus proche; ce qui a incité le Gouvernement du Sénégal à opter pour une stratégie d'éradication du vecteur et de la maladie, puisque le risque de réinvasion est minimal voire inexistant. Le projet a été exécuté sur la base d'une approche en phases ainsi échelonnée (1) la formation et l'engagement de toutes les parties prenantes, (2) la collecte des données de base et l' étude de faisabilité, (3) les activités pré-opérationnelles et (4) les activités opérationnelles. Le système de suivi entomologique mis en place dans les 3 blocs opérationnels de la zone du Projet a indiqué les résultats suivants: aucune capture de mouche sauvage depuis Août de 2012 dans le bloc 1, pendant que dans le bloc 2 et 3 les densités des populations tsé tsé sauvages sont présentement réduites à plus de 99 %. Par ailleurs, le suivi des troupeaux sentinelles de bovins situés à l'intérieur et à l'extérieur de la zone infestée par les mouches tsé-tsé a montré une réduction significative de la révalence de la TAA. Enfin, le suivi environemental a montré un impact très faible du Projet sur les espèces non-ciblées tandis que l'étude socio-économique a montré une haute rentabilité du projet.

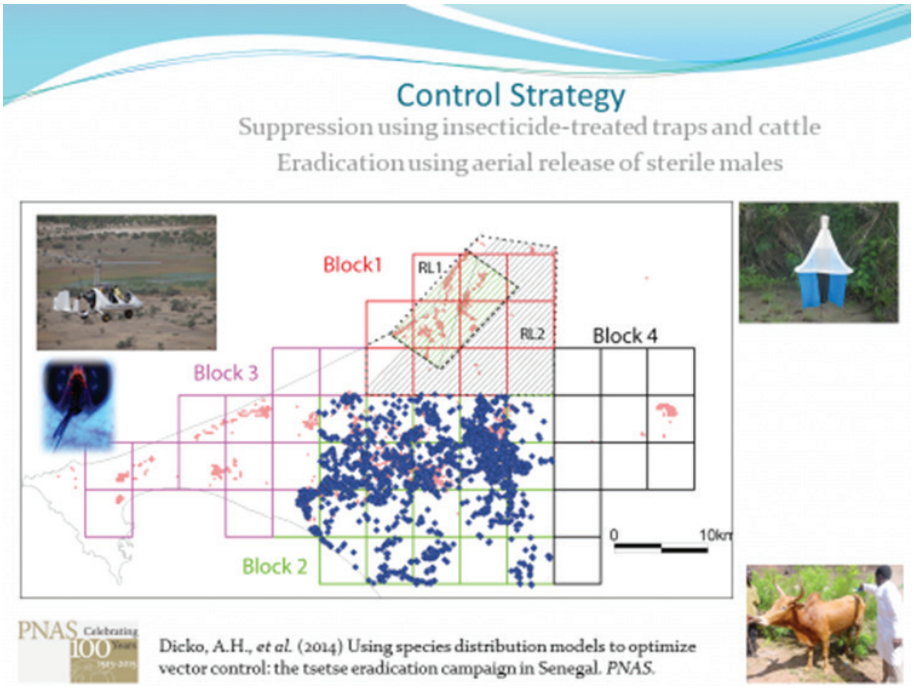
The "Projet de lutte contre la mouche tsé-tsé et la trypanosomose dans les Niayes" targets a total area of 7,350 km2, of which 1,375 km2 were infested with Glossina palpalis gambiensis (Diptera: Glossinidae) which were solely responsible for the cyclical transmission of trypanosomes, the causative agents of African animal trypanosomosis (AAT). The tsetse population in the Niayes was completely isolated from the main tsetse belt in the south eastern part of the country, which prompted the Government of Senegal to select an eradication strategy of the vector and the disease, as the risk of re-invasion would be minimal or non-existing.

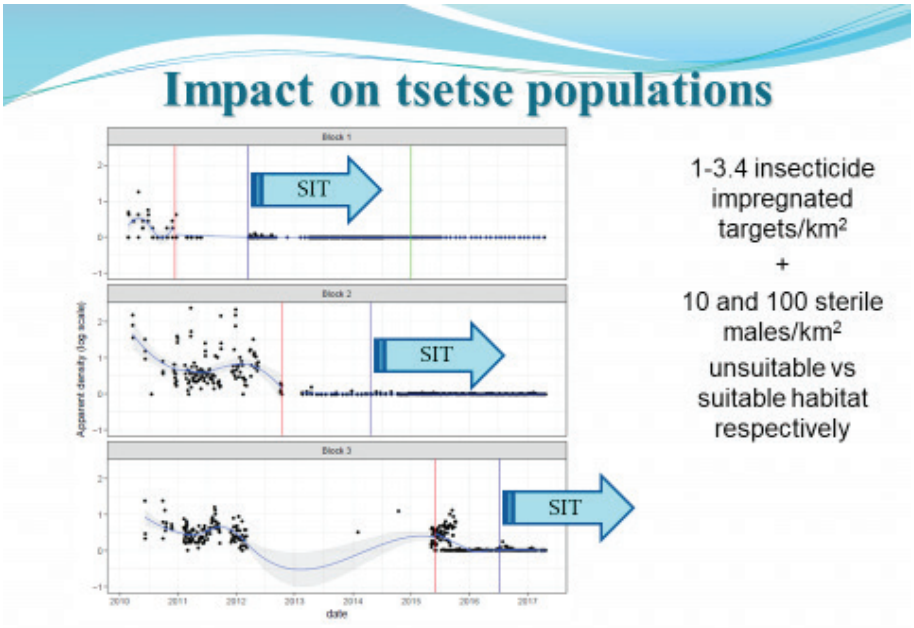
The project was implemented in different phases, i.e. following a phased conditional approach, which consisted of (1) training and commitment of all stakeholders, (2) baseline data collection (BLDC) and feasibility studies, (3) pre-operational activities, and (4) operational activities. During the BLDC, entomological, parasitological, environmental and socio economic data were collected to assess tsetse distribution, population dynamics, trypanosomosis prevalence and distribution, potential environmental impact, and anticipated



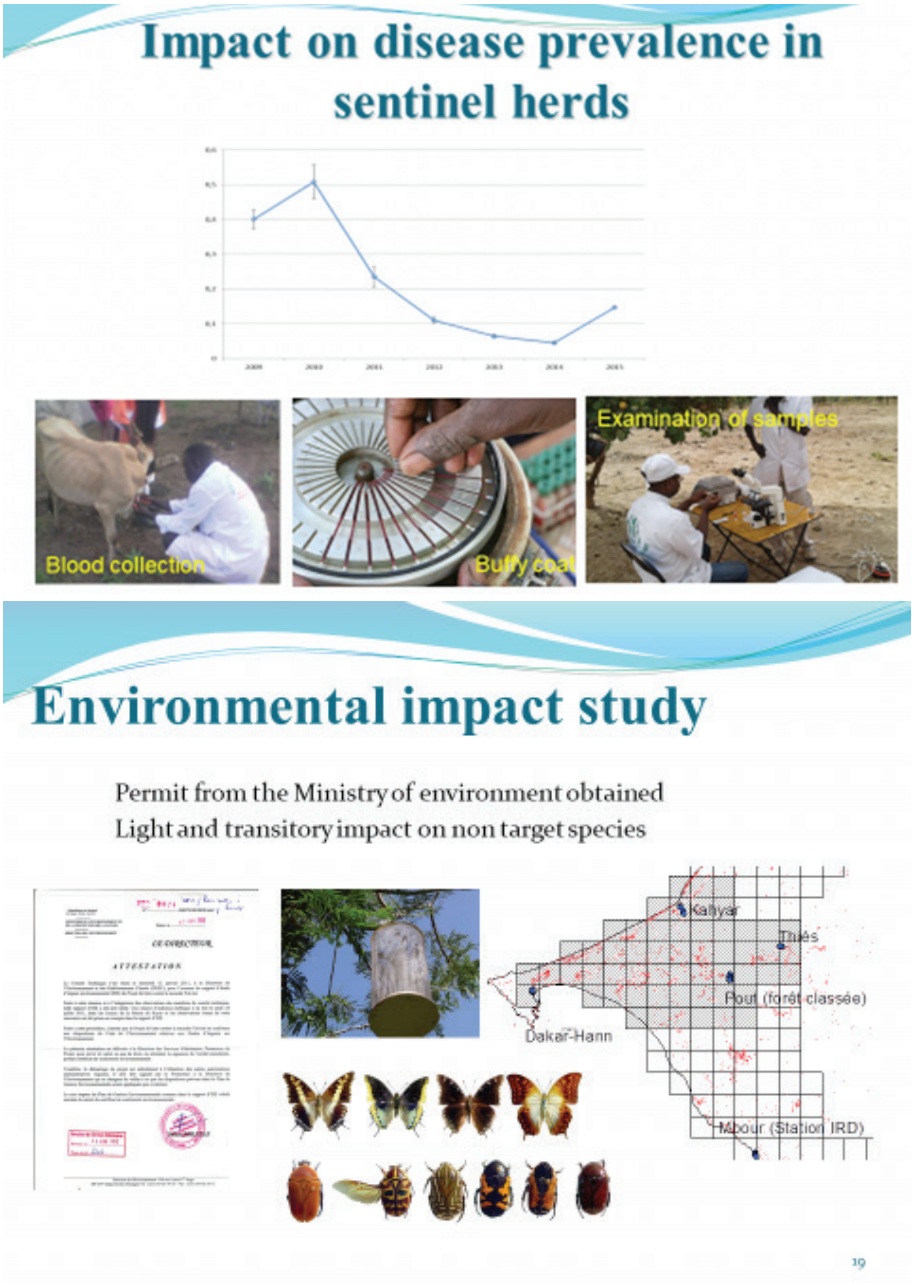
benefit-cost ratios. Activities during the pre-operational phase included the establishment of a colony of tsetse originating from the target area in Senegal, competiveness studies between the sterile flies and those from the target area, development of transport methods for long distance shipments of sterile male pupae, competitiveness of the sterile male flies after release in the target area, development of aerial release methods, including a new chilled adult release system, and development of a Maxent-based distribution model to guide the suppression, sterile male releases and the monitoring of the campaign. During the operational phase, the fly populations were suppressed using insecticide-impregnated traps (~3000), insecticide-treated cattle (~10,000 heads) and insecticide-impregnated fences around pig pens (~300 m). During the eradication phase, more than 3,000,000 sterile male tsetse flies have so far been released from the ground or by air.

An extensive entomological monitoring system implemented in the 3 operational blocks indicated the following: no wild fly catches since August 2012 in block 1, while in block 2 et 3 the densities of the wild tsetse populations have been reduced by > 99% at the time of writing.

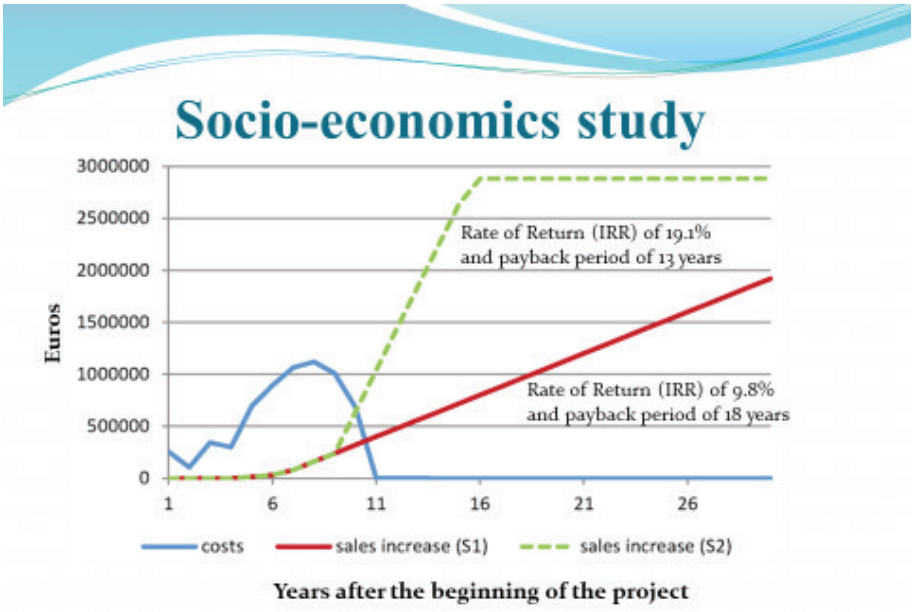




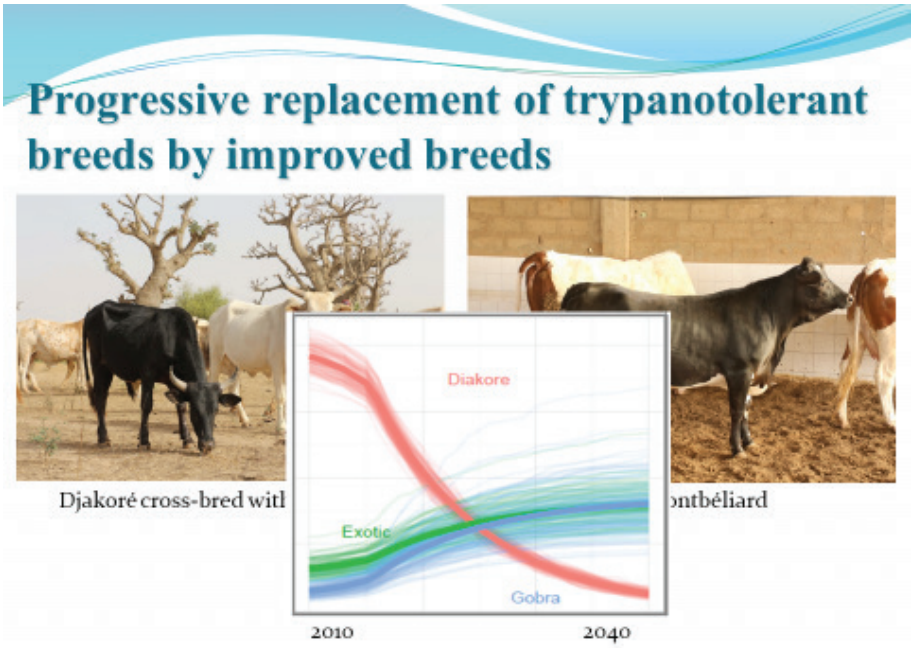
Monitoring data of sentinel herds located inside and outside the tsetse-infested area indicated already a significant reduction of the AAT prevalence.



A socio-economic study showed a high cost-effectiveness of the project.



The Djokore cross breed is progressively replaced by exotic breeds more productive as the disease is under control.



The implementation approach of this project could serve as a model for future potential tsetse eradication campaigns in sub-Saharan Africa.

HUMAN AFRICAN TRYPANOSOMOSIS / TRYPANOSOMOSE HUMAINE AFRICAINE

SURVEILLANCE PASSIVE INTENSIVE DE LA TRYPANOSOMIASE HUMAINE AFRICAINE DANS L'ÉTAT DU DELTA AU NIGERIA

INTENSIVE PASSIVE SURVEILLANCE FOR HUMAN AFRICAN TRYPANOSOMIASIS IN DELTA STATE, NIGERIA

Enwezor, F.N.C[1], Dede, P.M[1]., Ovbagbedia, P.R.[1], Onwumah, U[1].,Mamman, M[1]. ,Igweh, A.C[1]., Anagbogu, I[2]., Uzoma, E[2]., Uduak, G[2]., Okeowo, P[3]., Arugba, D[3]., Otobo, E.S[3]., Oseji, M. I.[3], Biéler, S[4] and Ndung'u, J. M[4].*

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Résumé

Au Nigéria, la trypanosomiase humaine africaine (THA), causée par Trypanosoma brucei gambiense, est chronique et présente des manifestations cliniques non spécifiques tardives, de sorte que les patients peuvent être asymptomatiques pendant des années avant de développer des signes cliniques et – si la maladie n'est pas identifiée et traitée – ils meurent. Le dernier cas confirmé de THA au Nigéria a été signalé en 2013. En 2014, NITR, FIND et le Ministère de la Santé du Nigéria ont lancé une collaboration visant à éliminer la THA d'ici 2020. L'objectif spécifique était de déterminer la faisabilité de l'élimination de la THA au Nigéria par un dépistage passif intensif en utilisant une nouvelle stratégie qui combine l'utilisation de HAT-RDT, la microscopie à fluorescence LED et la LAMP intégrée dans le système de soins de santé primaires.

Cinquante-et-un établissements de santé ont reçu du matériel et ont été autorisés à utiliser SD-BIOLINE HAT-RDT pour identifier les cas suspects. En 2016, le nombre d'installations pour les tests de confirmation est passé de quatre (4) à 25, afin d'améliorer la détection des cas et de réduire la distance que les suspects positifs par TDR doivent parcourir pour la confirmation de leur état. En mars 2017, 7 310 patients ont été soumis au dépistage par HAT-RDT, et 211 (2,89%) étaient positifs, dont soixante-cinq se sont présentés pour des tests de confirmation et étaient négatifs pour parasitologie et LAMP. Étant donné qu'aucun cas de THA n'a été identifié jusqu'à présent, la stratégie a été revue pour une surveillance passive ciblée, plus rentable et plus durable dans 19 établissements de santé qui examinent les cas suspects cliniques par des

HAT-RDT et effectuent des tests de confirmation par microscopie. On espère que la nouvelle stratégie confirmera les résultats des tests de cas soupçonnés de THA et générera des données pour appuyer l'élimination de la maladie au Nigéria.

Abstract

Human African trypanosomiasis (HAT) in Nigeria caused by Trypanosoma brucei gambiense is chronic with delayed non-specific clinical manifestations, such that patients could be asymptomatic for years before developing clinical signs, and if unidentified and treated, they die from the disease. The last confirmed case of HAT in Nigeria was reported in 2013. In 2014, NITR, FIND and the Ministry of Health of Nigeria initiated a collaboration to eliminate HAT by the year 2020.

The specific objective was to determine the feasibility of eliminating HAT in Nigeria by passive intensive screening using a novel strategy that combines use of HAT-RDTs, LED-fluorescence microscopy and LAMP integrated into the primary healthcare system. Fifty- one health facilities were equipped and empowered to use the SD-BIOLINE HAT-RDT to identify suspected cases. In 2016, the number of facilities for confirmatory testing were increased from four (4) to 25, to improve case detection and reduce the distance that RDT positive-suspects have to travel for status confirmation. By March 2017, 7,310 patients had been screened with HAT-RDTs and 211 (2.89%) were positive, of which sixty-five presented for confirmatory testing and were negative for both parasitology and LAMP. Since no HAT case has so far been identified, the strategy has now been reviewed to a more cost-effective and sustainable-one of targeted passive surveillance in 19 health facilities that screen clinical suspects with HAT-RDTs and perform confirmatory testing by microscopy. It is hoped that the new strategy will confirm testing of suspected-HAT cases and generate data to support elimination of the disease in Nigeria.

Introduction

Human African Trypanosomiasis (HAT), also known as sleeping sickness is a debilitating disease caused by Trypanosoma brucei gambiense in West and Central Africa or Trypanosoma brucei rhodesiense in East and Southern Africa. HAT is vector-borne and spread by tsetse flies of the genus Glossina, which are prevalent in remote areas of Sub-Saharan Africa, including in Nigeria. In affected rural populations, sleeping sickness due to T. b. gambiense runs a chronic asymptomatic course for years prior to symptoms onset. Therefore, if unidentified early for prompt treatment, patients could die from the disease.

Nigeria is on the World Health Organization (WHO) list of countries that report less than 100 new cases of HAT per annum (Simarro, 2010). In 2012 only seven (7) cases were reported in Delta State (Franco et al., 2014). The low number of cases reported annually suggests that HAT may no longer portend serious concerns to public health (WHO, 2012); however, the risk of reemergence of the disease still exists. In 2014, the Nigerian Institute for Trypanosomiasis Research (NITR), The Foundation for Innovative New Diagnostics (FIND) and the Federal and Delta State Ministries of Health of Nigeria commenced a collaboration to eliminate HAT by the year 2020. The specific objective was to determine the feasibility of eliminating HAT in Nigeria by intensive passive screening using a novel strategy that combined use of HAT rapid diagnostic tests (SD BIOLINE HAT RDTs), LED fluorescence microscopy (FM) and a molecular method named Loop-mediated isothermal amplification (LAMP) integrated into the primary healthcare system. Here, we present the results of a three-year pilot intensive passive surveillance strategy aimed at early case detection and management towards elimination of sleeping sickness.

Materials and methods

The study to assess the feasibility of integrating an intensive passive screening strategy for HAT elimination in the general healthcare system in Delta State, Nigeria was multi-centered and for an initial period of three years (2014-2017). The project began with mapping and characterization of 61 health centers out of which 57 were selected based on accessibility and coverage by mobile phone, among others. Renovation and upgrading of three out of the four reference hospitals (Government Hospital Abraka, General Hospital Obiaruku and Central Hospital Kwale; the Eku Baptist Government Hospital was not upgraded because it had just undergone major renovation by the State Government) and delivery of laboratory equipment and consumables. Trainings to enhance the capacity and skills of the medical laboratory professionals to implement the tests (HAT RDTs, LED FM and LAMP) were conducted by experts supported by FIND. A total of 45 trainees out of 53 (84.9%) from RDT centers were trained and all 7 (100%) from the four reference centers were trained on RDT, LED fluorescence microscopy and LAMP.

A second training by NITR afforded an opportunity to bring on board those medical laboratory personnel, who due to industrial action missed the first training exercise, bringing the total to 52 medical laboratory professionals that received trainings. Hence the stage was set for implementation of activities. In addition, medical personnel (doctors and/or nurses) received training on HAT clinical diagnosis, treatment and management. Two medical doctors and a nurse were sponsored by WHO to travel to the Democratic Republic of the Congo (DRC) to be trained on HAT treatment, control and management.

Test implementation

Altogether 51 health centers were equipped and empowered to use the SD BIOLINE HAT RDTs to screen and identify suspected cases. Patients subjected to the test were those with complaints of frequent fever, persistent malaria, prolonged cough or other ailments that saw them frequenting the health centers. With further training in 2016, the number of facilities able to perform confirmatory testing was increased from four (4) to 25, to improve case detection and reduce the distance RDT positive suspects would have to travel for confirmatory diagnosis. The LAMP center performed molecular tests on clinical samples collected from RDT positive suspects who were negative by microscopy.

Results and discussion

By March 2017, 7745 patients had been screened with HAT RDTs and 210 (2.71%) were positive suspects. Sixty-five of these suspects presented for confirmatory testing and were negative for both parasitology and LAMP. Since no HAT case was found, the project was downscaled from intensive screening in 51 facilities to targeted passive surveillance in 19 health centers that are equipped to screen clinical suspects with HAT RDTs and perform confirmatory testing by microscopy. This is expected not only to improve cost-effectiveness and sustainability, but also to generate data to validate elimination of the disease in Nigeria. The absence of HAT cases that was found during the pilot study suggests that sleeping sickness might not pose a major health problem in Delta State. However, a possible reemergence of the disease in Nigeria cannot be ruled out, and could be facilitated by the migration of HAT cases and by man-fly contact within forest areas.

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COMPARATIVE EVALUATION OF SEROPARASITOLOGICAL RESULTS IN TRYPANOSOMES (2004 – 2017)

EVALUATION COMPARATIVE DES RESULTATS SEROPARASITOLOGIQUES CHEZ LES TRYPANOSOMES PÉRIODE 2004 – 2017

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Abstract

The National Trypanosomiasis Control Program was established nearly thirty-two years ago. The programme was launched in the 1980s, following an upsurge of Human African Trypanosomiasis (HAT) cases in Equatorial Guinea. It has been in existence since 1985, and is mainly focused on diagnosis, treatment of HAT cases, follow-up and LAV in the 4 historical outbreaks: one in Luba island and the other three on the hinterland (Rio Campo, Mbini and Kogo). In 1998, the last case of HAT was diagnosed in Luba, and no cases have been reported in this outbreak for the past 20 years. Therefore, our efforts have been focused on Mbini, Kogo and Rio Campo outbreaks.

On a regular basis, the Program carries out HAT epidemiological surveillance both at the central laboratory level and in the periphery, or in close collaboration with the Passive Screening Centers (CDP), so that methodologies for diagnosing the disease have been using CATT from the 80s to the present day.

And since 2013, following WHO's initiative that introduced Rapid DiagnosticTests (RDTs) as the most important diagnostic tool for active and passive detection of the disease. For years, drugs used within the program have been Pentamidine, Melarsoprol, and Eflornithine. Since 2010, the Program has been using a combination of Nifurtimox, Eflornithine (NECT) plus the other medicines mentioned.

Our observation study here draws our attention to the importance of parasitological diagnosis in trypanosomes. However, examining a patient doesn't mean screening him/her serologically only, but also involves variable methodologies used under the Program to establish a confirmed positive result. Our observation is based on case 1/17 / T from the village of Edjabe, Rio Campo focus straddling the two countries separated from Campo (Cameroon) focus by N'tem River.

This last case died before treatment. The patient had stayed in his home for more than eight months. During the last survey conducted in the focus, he was absent. He had several seizures at home, and had the following symptoms: facial edema, difficulties to walk, fever, intense drowsiness, fatigue. However, he has undergone all serological tests, but these proved to be negative. Through lumbar puncture, cytorachia had 23 elements without evidence of the parasite in the other parasitological examinations, with the exception of the blood smear with Giemsa which revealed a hundred trypanosomes.

Résumé

Bientôt trente-deuxième années que le Programme National de Contrôle de la Trypanosomiase a été crée. Dans les années 80, du fait de la recrudescence des cas de Trypanosomiase Humaine Africaine (THA) en Guinée Équatoriale ce Programme National a vue le jour. Il existe depuis octobre 1985, et repose principalement sur le diagnostic, le traitement des cas de THA, suivi et la LAV dans les 4 foyers historiques, l'un insulaire (Luba) et les trois autres continentaux (Rio Campo, Mbini et Kogo).En 1998, le dernier cas de THA a été diagnostiqué à Luba, et aucun cas n'a été répertorié dans ce foyer a peu près 20 ans. Nos efforts ont donc porté sur les foyers de Mbini, Kogo et Rio Campo.

Régulièrement le Programme réalise leurs activités de surveillance épidémiologique de la THA tant au niveau du laboratoire central que dans la périphérie, soit une étroit collaboration avec les Centre de Dépistage Passif(CDP), et si bien que les méthodologies de diagnostiques de la maladie est basé sur le CATT depuis les années 80 jusqu´à nos jours. Et depuis 2013, avec l´initiative de l´OMS de l'introduction de Test Rapide (TDR) comme l´outil de diagnostique très important sur la détection actif et passif.

Les médicaments utilisés au Programme depuis des années ont été la pentamidine, le melarsoprol, l´eflornithine. En 2010, le Programme utilise la combinaison de nifurtimox, eflornithine(NECT) en plus les autres médicamentents mentionnés.

Introduction

La Trypanosomiase humaine africaine(THA) ou maladie du sommeil, reconnue par la population équatoguinéenne comme MEKI-ABE (mauvais de sang) est une maladie parasitaire causée par des protozoaires flagellés et sanguicoles transmit par la piqure de la mouche tse-tse ou glossines. Quatre foyers historiques sont reconnus si longtemps en Guinée Équatoriale. Ce pays de l´Afrique central située dans la partie occidentale du Continent africain au fond du golfe de Guinée. Et limite au Nord avec la République du Cameroun, à l´Est et au Sud avec le Gabon et a l´Ouest avec l´océan Atlantique. Elle a une frontière maritime avec la République Fédérale de Nigeria et Sao Tomé.A une surface de 28.051 Km², avec une région continental de 26.017 Km²(Rio Muni),et par l´océan Atlantic à l´ouest; et une région insulaire qui comprend l´île de Bioko, Annobon, Corisco, Elobey Grand, Elobey Chico et de petites îles adjacents. Au Bioko (2034 Km²) se trouve la capital Malabo. Le climat tropical, abondantes précipitations en deux saisons annuelles (1.700 à 4.000 litres), intercalés à deux saisons sèches. Température moyenne de 35ºC, humidité relatif 98 %.Le territoire est traversé par deux grands fleuves, quelques régions montagneux et couvert par un 65% de la zone de forêt tropicale equatoguinéenne qu´occupe près de 86% du territoire et dispose de plus de 800 espèces végétales différents. Ce caractéristiques de forêt et des stagnations d´eaux favorisent la propagation de maladies comme la trypanosomiase, le paludisme et autres. Dans l´ile de Bioko existent deux grandes formations volcaniques, séparés par le vallée de Moka. Principal altitude Pico Basile de 3.008 mètres. Dans la région continentale, auprès de la côte existe une région de plaine interrompue par marécages. A l´intérieur, le terraine s´éleve vers les massifs de Mitra(1.200 mètres), Chocolate, Chime et Piedra Nzas. La démographie est de 1.014.999 habitants. Administrativement le pays comprend deux régions et huit Provences, 8 provinces dont 7 glossiniques et 2 endémiques de THA, (Bioko sud, région insulaire et Littoral, région continental) Soit: 28.034 Km2 avec Tsé-tsé. Le 3/4 du territoire infesté et 3/4 de la population sous risque dont deux sont glossiniques,

Méthodologie:

Une étude d´observation descriptive et de cohorte rétrospective a été réalisé dans les foyers de Mbini et Rio Campo entre juin 2004 et mars 2017. Les résultats que nous présentons ici, sont obtenus à partir des enquêtes séroparasitologiques menées à Luba, Rio Campo, Kogo et

Mbini, via utilisation du:

*le CATT et du Test Rapide (TDR)

*la PG (ponction ganglionnaire)

*la m-AECT(mini-colonne)

* la GE(goutte épaisse – frottis sanguine)

*la CTC(centrifugation en tube capillaire)

*la PL(ponction lombaire)

*la CSM (centrifugation simple modifie)

Résultats: Au cours de nos étude d´observation 14 cas ont été rapporté, dont les résultats seroparasitologiques utilisés ci-bas(tableau 1)

Répartition des sujets d´étude en fonction de CATT, TDR et Trypanolise

Nombre de Sujets: Code	**Nature d´examen**			**Parasite Cels**	**Résultats**
	CATT	**TDR**	**TL(1)_**		
Cas confirmé					
1)1/04/D	Neg.	NR	NR	T+	3
2)1/05/D	Neg.	NR	NR	T+	4
3)11/04/T	Neg.	NR	NR	T+	26
4)13/04/T	Neg.	NR	NR	T+	102
5)9/07/T				T+	
6)13/08/T				T+	
7)1/17/T	Neg.	Neg	NR	T+	23
8)1/17/D	Pos.(1/2)	Neg	NR	T0	13.3
9)2/17/T	Pos.(1/2)	Neg	NR	T+	50
10)4/17/T	Pos(1/16)	Pos	NR	T0	11.66
No confirmé					
Suspect serologiques(No confirmés, no traités)					
11) 5/Etomb/17	Neg.	Pos.	NR	NR	
12) 3/Engong/17	Neg.	Pos.	NR	NR	
13) 14/Mikom/17	Pos(-½)	Neg.	NR	NR	
14)36/Mangala/17	Pos(-½)	Neg.	NR	NR	

N.B.: Les suspects 11, 12, 13, 14, sont de résultats sérologiques no confirmés ni traités, et les différents résultats non optimale entre les CATT et TDR dans les foyers de Rio Campo et Mbini.

Les échantillons pour la Trypanolises ne sont pas envoyés à CIRDES.

Traitements administrés

1) 1/04/D	Pentamidine
2) 1/05/D	Pentamidine
3) 11/04/T	Eflornithine
4) 13/04/T	Eflornitine
5) 9/07/T	Eflornithine
6) 13/08/T	Eflornithine
7) 1/17/D	Pentamidine
8) 1/17/T	Un patient était décède avant le traitement(2).
9) 2/17/T	Nect
10)4/17/T	Pentamidine

Légende :

(1) TL : la methodologie de Trypanolise

(2) Un patient de 17 ans en detection en passif parasitemie très élèvé au frottis. Decede avant le traitement

Conclusion: Notre étude d´observation ici nous tire l´attention sur l´importance de diagnostique parasitologique chez les trypanosomés

Toute fois, il ne suffit pas de diagnostiquer le malade sérologiquement, l'outil de méthodologies au Programme sont variable pour aboutir à un résultat positif confirmé.

Notre observation sur le cas 1/17/T venant du village d´Edjabe, foyer de Rio Campo séparé par le fleuve N´tem aux deux pays le foyer de Campo(Cameroun). Ce cas dernièrement décède avant le traitement. Depuis plus de huit mois que le malade été chez lui. A la dernier prospection réalisé au foyer, il été absent. Il a fait de plusieurs convulsions a la maison, et venant avec œdème faciale, les troubles de la marche, fièvre, très sommeilleux, fatigue. Cependant il a subit de tous des méthodes sérologiques et négatifs. À la ponction lombaire, la cytorachie a 23 éléments sans l´évidence du parasite dans les autres examens parasitologiques à l´exception du frottis sanguin avec Giemsa qui donnera une centaine de trypanosomes.

Mots clés : Évaluation comparative des Résultats Seroparasitologiques no optimales entre CATT et TDR chez les Trypanosomés. Période 2004 - 2017

CAPACITÉ ET CHANGEMENT DE POLITIQUE DANS LA GESTION DE LA TRYPANOSOMIASE HUMAINE AFRICAINE DANS LES DISTRICTS SANITAIRES DES ZONES RURALES OÙ LA MALADIE EST ENDÉMIQUE DANS L'EST DE LA ZAMBIE

CAPACITY AND POLICY CHANGE IN MANAGING HUMAN AFRICAN TRYPANOSOMIASIS IN ENDEMIC RURAL HEALTH DISTRICTS OF EASTERN ZAMBIA

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Résumé

Introduction

- La trypanosomiase humaine africaine (THA) est une zoonose et reste un important problème de santé publique en Afrique.
- Les gouvernements des pays affectés n'ont pas mis au point depolitiques mûrement réfléchies pour gérer la plupart des maladies, y compris la THA (Simarro et al, 2011).
- L'OMS estime que plus de 70 millions de personnes sont exposées à la maladie, et seule une petite fraction est sous surveillance.
- La Zambie ne dispose pas de structure spécialisée pour la surveillance ou le contrôle de la THA dans les zones affectées (Mwanakasale et al,2011; Mulenga et al, 2015).
- En 2014, le district de Rufunsa en Zambie a signalé à lui seul neuf nouveaux cas (University of Zambia, 2014), suscitant ainsi beaucoupd'inquiétudes

Objective

- Faire des investigations et comparer les capacités de diagnostic et de gestion de la THA dans les centres de santé situés dans les districts de Chama et Mambwe infestés de glossines dans l'Est de la Zambie.

Methodolody

- Des questionnaires structurés ont été utilisés pour recueillir l'information

auprès de 110 agents de santé issus de 23 RHC dans une étude comparative transversale réalisée entre avril et juillet 2013.

- Au moins 50% de l'ensemble du personnel présent issus des districts échantillonnés ont été captured, mais en raison du faible niveau de dotation, 79% et 80% du personnel des districts de Chama et Mambwe ont été captured.
- Stata/SE version 11.0 a été utilisée pour analyser les données collectées.

Results

- Occasions manquées de détecter la THA par rapport aux cas de paludisme dans les districts de Chama et Mambwe (P = 0,027).
- Le personnel des deux districts avait une préférence pour la détection d'affections liées à la fièvre plutôt que la THA tel que revu dans la direction de la plupart des services gouvernementaux et privés (P = 0,007).
- Le personnel du district de Chama était plus susceptibles de détecter les cas de THA par rapport à leurs homologues de Mambwe (P <0,001) en raison de cas signalés précédemment.

Discussion

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Conclusion

- La THA a de graves conséquences sociales et économiques, qui dépassent de loin le coût du maintien des activités de surveillance.
- L'élimination de la THA est techniquement réalisable et économiquement justifiable comme l'une des premières étapes importantes dans les efforts africains d'atténuation de la pauvreté.

Recommendations

- Formation continue dans la prise en charge de la THA pour les prestatiares

de soins de santé dans les zones où la maladie est endémique ;

- Des lignes directrices stratégiques normalisées doivent être distribuées aux RHC pour guider la prestation de services par rapport à la THA ;
- Disponibilité d'outils de diagnostic appropriés pour la détection de la THA ;
- Intégration des activités de contrôle dans des réformes des systèmes de santé élargis.

Abstract

Introduction

- Human African Trypanosomiasis (HAT) is a zoonosis and remains an important public health problem in Africa.
- Governments in affected countries have failed to come up with deliberate policies to manage most diseases including HAT (Simarroet al, 2011).
- WHO estimates over 70million people are exposed to the disease with only a fraction under surveillance
- Zambia has no dedicated structure for surveillance or control of HAT in affected areas (Mwanakasale et al, 2011; Mulenga et al, 2015).
- In 2014, Rufunsa district of Zambia alone reported 9 new cases (University of Zambia, 2014) raising a lot of concern.

Objective

- To investigate and compare capacities to diagnose and manage HAT at health centres located in tsetse infested Chama and Mambwe districts of Eastern Zambia.

Methodolody

- Structured questionnaires were used to collect information from 110 health personnel drawn from 23 RHCs in a cross sectional comparative study undertaken between April and July 2013.
- At least 50% of the total staff present from the sampled districts were to be captured but due to low staffing levels, 79% and 80% of personnel from Chama and Mambwe districts respectively where instead captured
- Stata/SE version 11.0 was used to analyze collected data.

Results

- Missed opportunities to detect HAT compared to malaria cases between Chama and Mambwe districts (P=0.027).
- Staff from both districts had preference to detect fever related conditions rather than HAT as reviewed in the direction of most Government and private support (P=0.007).
- Staff from Chama district were less likely to miss HAT cases compared to their Mambwe counterparts (P<0.001) due to previous reported cases.

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Conclusion

- HAT has serious social and economic consequences, which far outweigh the cost of maintaining surveillance.
- Elimination of HAT is technically feasible and economically justifiable as one of the important initial steps in Africa's efforts to alleviate poverty.

Recommendations

- Continued education in HAT management for health care providers in HAT endemic areas
- Standardized policy guidelines to be distributed to RHCs to guide in the provision of services in relation to HAT
- Availability of appropriate diagnostic tools for detecting HAT
- Integrating control activities into wider health system reforms

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AFRICAN ANIMAL TRYPANOSOMOSIS
TRYPANOSOMOSE ANIMALE AFRICAINE

PRÉVALENCE PARASITOLOGIQUE DE LA TRYPANOSOMOSE BOVINE DANS LA DIVISION KUBO DU COMTÉ DE KWALE : ÉTUDE DE BASE PARASITOLOGICAL

PREVALENCE OF BOVINE TRYPANOSOMOSIS IN KUBO DIVISION OF KWALE COUNTY OF COASTAL: BASELINE SURVEY

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Résumé

Avant les essais sur le terrain de la technologie à répulsifs validée pour la lutte anti-glossines à grande échelle en juillet 2011, une étude transversale de la trypanosomose bovine et de ses vecteurs a été menée dans le but de connaître le niveau de la maladie dans le comté de Kwale dans la région côtière du Kenya. Au total, 584 bovins adultes ont été examinés dans dix endroits différents. La prévalence du trypanosome chez les bovins selon l'âge, le sexe, l'emplacement et la densité apparente de mouches tsé-tsé a été étudiée. La prévalence globale du trypanosome chez les bovins de la division Kubo du comté de Kwale était de 33,9%. Deux types d'infections ont été relevés dans différentes parties de la Division, dans les proportions suivantes : T. congolense 61,1%, T. vivax 38,9%. Les résultats de cette étude ont indiqué que la prévalence du trypanosome dépendant de l'emplacement peut être stratifiée à trois principaux niveaux : Élevé (Mkongani 16,7%) ; Très élevé (Kizibe 25%, Zunguluka 25,5% et Mangawani 26,7%) et Éxtrêmement élevé (Katangini 32,2%, Mkanda 34,4%, Msulwa 42,4%, Mawia 46,4% et Kidongo 52,5%). La densité apparente moyenne de G. pallidipes était de 30 mouches / piège / jour tandis que celle de G. austeni était de 0,8 mouches / piège / jour, et celle de G. brevipalpis de 0,4 mouches / piège / jour. On a relevé une corrélation positive et significative ($p < 0,05$, $r = 0,82$) entre la prévalence du trypanosome et la densité apparente des glossines. Compte tenu du risque de trypanosomose, la Division a été sélectionnée pour des essais d'envergure de la nouvelle technologie à répulsifs validée pour la lutte anti-glossines à grande échelle sur le terrain.

Mots-clés : Division de Kubo, District de Kwale, Prévalence, trypanosomose, technologie à répulsifs de lutte contre les glossines

Abstract

Prior to field trials of large scale tsetse repellent technology validation in July 2011, a cross-sectional survey of bovine trypanosomosis and its vectors was carried out to know the disease level in Kwale County of Coastal Kenya. A total of 584 adult cattle were examined at ten different Locations. The trypanosome prevalence in cattle with regard to age, sex, location and apparent tsetse density was investigated. The overall trypanosome prevalence in cattle in Kubo Division of Kwale County was 33.9%. Two types of infections were recorded in various parts of the Division in the following proportions: T. congolense 61.1%, T. vivax 38.9%. Findings from this study indicated that the Location dependent trypanosome prevalence can be stratified in three main levels: high (Mkongani 16.7%); very high in (Kizibe 25%, Zunguluka 25.5% and Mangawani 26.7%) and extremely high in (Katangini 32.2%, Mkanda 34.4%, Msulwa 42.4%, Mawia 46.4% and Kidongo 52.5%). The mean apparent density for G. pallidipes was 30 flies/trap/day while that of G.austeni 0.8 flies/trap/day and G. brevipalpis was 0.4 flies/trap/day. There was a positive and significant correlation ($p<0.05$, $r = 0.82$) between the trypanosome prevalence and tsetse apparent density. In view of the risk of trypanosomosis, the Division was selected for the large scale field trials of the new tsetse repellent technology validation.

Keywords: Kubo division, Kwale Disrtrict, Prevalence, trypanosomosis, Tsetse repellent technology ©2013 Science Publication. American Journal of Animal and Veterinary Sciences Volume 8, Issue 1, 11 April 2013, Pages 28-36

1. Introduction

Trypanosomiasis is one of the main constraints to sustainable livestock production in sub-Saharan Africa (Swallow, 1999) where about 50-70 million animals are at risk (Geerts et al., 2001). Tsetse flies (Glossina sp.), the principal vector of trypanosomes, inhabit about 10million km2 of the continent. Livestock trypanosomosis has adverse effects on rural development over vast areas (Holmes, 1997). Tsetse-transmitted trypanosomosis in human and domestic animals poses also a serious threat to the lives and livelihoods of entire communities and constitutes the greatest single constraint to livestock and crop production and to a more appropriate and responsible utilization of natural resources in Africa. The direct and indirect impacts of African Animal Trypanosomosis on agriculture constitute a major constraint to the socio-economic development of tsetse fly (Glossina) infested areas of Africa

(Swallow, 1999). Estimation of the annual economic impact by the Food and Agriculture Organization of the United Nations (FAO) establish that, every year, Africa loses over 3 million cattle and other domestic livestock through deaths caused by trypanosomosis. Approximately 35 million doses of trypanocidal drugs (worth about US $35 million) is bought every year in futile efforts to maintain livestock free of the disease. The annual loss directly attributed to trypanosomosis, in terms of reduced meat and milk production and in terms of the costs related to treating the disease or controlling the vector, has recently been estimated at US $1.2 billion. This figure rises to over US $4.5 billion per year, if losses in potential crop and livestock production attributable to the disease are considered and excludes the losses attributable to the effects of sleeping sickness in humans (PATTEC, 2000).

In endemic areas, trypanosomiasis reduces calving rates, milk yields, off take and oxen work efficiency whereas calf mortality is increased (Swallow, 1999). The disease, transmitted by tsetse flies, is caused by an infection with pathogenic trypanosomes. Such an infection causes an acute or chronic disease characterized by fever, anemia, loss of appetite and condition. Mortality and morbidity vary widely and depend on factors such as the host species and breed, the trypanosome species, the virulence of the parasite and the innate resistance of the host (Connor and Bossche, 2004).

Various options are available for the control of animal trypanosomosis; they include the suppression and/or eradication of tsetse populations (Jordan, 1986), the use of trypanotolerant breeds of livestock (D'Ieteren et al., 1998), chemotherapy (Peregrine, 1994) or combinations of these (Holmes, 1997). But today, the current unfavorable economic environment has prompted a shift in emphasis from large-scale tsetse eradication campaign to small-scale, sustainable and environmentally friendly trypanosomosis control. As a consequence, control focuses on areas where bovine trypanosomosis is a constraint to development and where disease management practices can be improved, knowing that animal traction plays an important role in the intensification of crop production in developing countries.

This present study sought to obtain prevalence estimates of bovine trypanosomosis, transmitted by tsetse flies and the apparent density of tsetse and biting flies around Shimba hills national reserve, prior to field trials of large scale tsetse repellent technology validation in July 2011.

2. MATERIALS AND METHODS

2.1. Study Areas

This study was carried out in Kubo Division, Kwale County in the Coast Province of Kenya. Kwale County lies between latitudes 3°3'S and 4°45'S south and longitudes 38°31'E and 39°831'E. Kwale County covers an area of 1,043 km2 which is divided into two administrative divisions, namely Matuga and Kubo divisions: the study area (Fig. 1) is situated in Kubo division. The populations of Kubo and Matuga division based on 2009 census were estimated to be 649,931 and 151,978 persons, respectively (Njenga et al., 2011).

Map 1

It borders Taita Taveta to the West, Kilifi district to the North West, Mombasa and Indian Ocean to the East and Republic of Tanzania to the South. Kwale County has four major topographical features namely the coastal plain, the foot plateau, the coastal uplands and the nyika plateau. The coastal uplands our study site, commonly known as Shimba Hills rises steeply from the foot plateau to an altitude of 150-462 m above sea level. They are composed of the mazeras sandstones. The hills include the Shimba Hills (420 m), Tsimba (350 m) and Dzombo (462 m). This is an area of medium to high agricultural potential (Jaetzold and Schimdt, 1983). In terms of climate, the County is hot and dry from January to March and relatively cool from June to August. Rainfall pattern is bimodal with long rains normally occurring between mid March and June while the short rains occur between October and December. The County has an average rainfall ranging from 400-1200 mm. The mean annual minimum and maximum temperature are 24 and 36°C, respectively and the County is long rain dependant for its farming activity. Seasonal rivers and the Ramisi River form the drainage pattern in the district. The main rivers and streams are Marere, Mwalunganje and river Ramisi. Due to the fact that Kwale has Shimba Hills National Reserve and on its boundary with Taita Taveta is Tsavo National Park, this area is endowed with variety of wild game like elephants, buffaloes, warthogs, bush pigs, sable antelopes, waterbucks, leopards and monkeys among others. This makes it a good breeding environment for tsetse fly and one of the hotspot areas of human-wildlife conflict brought about mainly by elephants. The most affected areas are those mainly surrounding Shimba Hills National Reserve in Kwale and Samburu-Mackinon areas of Kinango. Though the area is suitable for mixed farming, factors such as high evapo-transpiration rates, unreliability of rainfall, human-wildlife conflicts and tsetse infestation make this difficult (Thorpe et al., 1993). Subsistence farming of food crops including maize, cowpeas and cassava is done mainly for domestic consumption whereas coconuts, oranges, mangoes and cashew nuts are also grown for both domestic consumption and as cash crops. The main livestock kept include cattle, goats, ducks and chickens (Njenga et al., 2011).

2.2. Survey of Bovine Trypanosomosis

2.2.1. Sampling

Ten locations were randomly selected around Shimba Hills National Reserve. Assuming estimated trypanosomosis prevalence of 50% and with a desired accuracy of 5% at the 95% confidence level, an estimated sample size of 482 cattle was obtained (Cannon and Roe, 1982). To improve on the reliability of the sample size, more than the required number of animals was taken (584 cattle) in the Division. The number of animals selected in each location was based on proportional weighting. At the village level herds were selected by simple random sampling. The number of cattle sampled from a particular herd in a given village depended on proportional weighting; but a minimum of 4 cattle per herd was fixed. Where a chosen herd did not have the required number of cattle, (as calculated by proportional weighting), a second herd was selected by random sampling and the remaining number of cattle made up for by simple random sampling. At the end of the exercise around ten or eleven herds were selected between all the cattle keepers by location. The sex, age: Heifer ≤1 year and adult >1 year and weight of animals were noted.

2.3. Parasitological Survey

Parasitological method was used for diagnosis. Blood was collected from an ear vein into two heparinized micro-haematocrit centrifuge capillary tubes. The capillary tubes were sealed with "Cristaseal" (Hawksley) and centrifuged immediately in a microhaematocrit centrifuge for 5 min at 9000 rpm after sampling (Murray et al., 1977). After centrifugation, the Packed Cell Volume (PCV) was determined. Animals with a PCV≤24% were considered to be anaemic. The Buffy coat and the uppermost layer of red blood cells of the first specimen were extruded onto a microscope slide, covered with a cover-slip and examined for the presence of mobile trypanosomes. Samples were examined with a phasecontrast microscope with a x40 objective lens.

2.4. Entomological Survey

A total of 20 Ngu traps (Vestergaard Frandsen Group) were used to monitor tsetse and biting flies population in the study area. Two traps were deployed by Location. The coordinates of each trap position were recorded with a Global Positioning System (GPS). Traps were checked every day for three days. Records were kept of the number, species and sex of the tsetse captured in each trap. A daily mean Index of Abundance (IA) of tsetse was calculated as the mean number of flies (males and females) captured per trap per day.

2.5. Statistical Analyses

A t-test was used for all the means comparisons and the Stata 9.2 software

(Corp, 2006) was used.

3. RESULTS

3.1. Prevalence of Trypanosomiaisis

Using the Buffy coat technique, the mean prevalence of positive samples in Kubo Division was 33.9% (n = 198/584) for bovine trypanosomosis with Trypanosoma congolense 56.06% (n = 111/198) and T. vivax 43.94% (n = 87/198) being the pathogenic trypanosomes identified. A statistical significant difference ($p = 0.016<0.05$) was observed between the two pathogens in the Division. The prevalence of trypanosomosis varied among sampling sites (Table 1). The proportion of T. congolense infection was higher in Kidongo, Mkongani, Mkanda and Katanguini, while T. vivax was proportionnaly high in Pengo, Kizibe, Zunguluka, Mangawani and Msulwa (Table 1). The highest prevalence was recorded in Kidongo (52.46%) and the lowest in Mkongani (16.67%). In almost all survey areas, except Mawiya, the infection rate of T. congolense and T. vivax was significantly different ($p<0.05$) as shown also in Table 1.

3.2. Prevalence of Trypanosomiaisis Related to Age

Across the age spectrum of cattle, prevalence was significantly higher ($P = 0.002<0.05$) in the younger (age≤1 an) group 36.53% (n = 179/490) than in the older (age>1 an) group: 20.21% (n = 19/94). Also for the younger age, significant difference ($P = 0.026<0.05$) was observed between the pathogenic trypanosomes: 55.87% (n = 100/179) for T. congolense and 44.13% (n = 79/179) for T. vivax. But for the old age, no significant difference ($P = 0.33>0.05$) was observed between T. congolense and 57.89% (n = 11/19) and T. vivax 42.11% (n = 8/19).

3.3. Prevalence of Trypanosomiaisis Related to Sex

More male were infected but no significant difference ($p = 0.75 > 0.05$) was observed between infected male and female, 34.44% (n = 114/331) and 33.2% (n = 84/253), respectively.

3.4. Packed Cell Volume

The mean PCV for all cattle in the study area was 30.26±0.2%. The mean PCV of positive and negative animals ranged between 12-45% and 18-47%, respectively (Fig. 2). The average PCV of infected animals (26.83±0.4%) was significantly lower ($p = 0.0001$) than the average PCV of non-infected animals (32.01±0.1%). But the average PCV of infected cattle did not differ significantly ($p>0.05$) between trypanosome species: (26.35±5.6)

and (27.45±6.4) for T. congolense and T. vivax, respectively. Only 31.82% (63/198) of positive animals revealed PCV reading of less than 24% while 33.84% (67/198) of positive animals showed PCV readings of higher than 28% but no significant difference ($p = 0.67<0.05$) was found between the two groups. The PCV value that is usually used as a cut-off for anaemia in cattle is (PCV<24%). Fourteen animals (18.18%, 14/77) with PCV readings of below 24% were negative for trypanosomes, whereas (68.18%, 135/198) with PCV reading above 24% were found positive for trypanosomes. The mean PCV decreased with increasing proportion of positive animals.

3.5. Tsetse and Biting Flies Population

Throughout the range of the tsetse survey area, the species found were Glossina pallidipes, G. austeni and G. brevipalpis but G. pallidipes was the most predominant species collected in all locations. There was a downward gradient in the apparent density of tsetse per site around the Shimba Hills National Reserve (Table 2). The apparent density varied widely between Locations. In the case of G. pallidipes, the number of tsetse flies caught per trap per day at a given Location varied between 8 (Pengo and Kidongo) and 76 (Zunguluka) with a mean of 30. G. pallidipes. In the case of G. austeni the catch per site varied between 0 and 6 with a mean of 0.8 flies per site per day; this species of tsetse fly was found only in five Locations of the areas surveyed. While, G. brevipalpis were found only in four Locations surveyed and the number of tsetse flies caught per trap per day varied between 0 and 4 with a mean of 0.4 (Table 2). Low population of Tabanidae were sampled in eight Locations and the number of flies caught per trap per day varied between 0 (Msulwa and Mangawani) and 1.3 (Zunguluka) with a mean of 0.5 (Table 3). Whereas Stomoxis were sampled in all sites and the number of flies caught per trap per day at a given Locations varied between 0.3 (Msulwa) and 4 (Pengo) with a mean of 1.7 (Table 3).

4. DISCUSSION

The distribution of trypanosomosis, as suggested by the prevalence, showed a more or less similar situation around the Shimba Hills National Reserve. In all the areas, animals were infected by trypanosomes. The parasitological examination revealed a prevalence rate of 33.9% for bovine trypanosomosis with T. congolense 56.06% and Trypanosoma vivax 43.94% being the pathogenic trypanosomes identified. This study is in agreement with the findings of other researchers in various parts of Africa (Leak, 1999; McDermott et al., 2003), but our finding differed with previous data collected in the same Division by Ohaga et al. (2007) and also from Orma Boran cattle raised in Galana Ranch (Coastal Province in Kenya), over the past decade (1990- 2000) indicated that there were significantly higher T. vivax infections in cattle as compared to T. congolense

infections (Bett et al., 2004). Probably Localities where infections were due to T. vivax could be an indication of the presence of other potential haematophagus insect vectors other than tsetse flies. There is evidence that noncyclically transmitted T. vivax infection has been detected in other tsetse-free areas in Africa (Roeder et al., 1984).

With a disease prevalence rate of 33.9%, bovine trypanosomosis is seen to be a constraint to development in the region; this is supported by earlier research findings (Ohaga et al., 2007) who found a prevalence of 25% in the County and also (Murilla et al., 1998; Mugunieri and Murilla, 2003; Muraguri et al., 2005). However, earlier reports also indicate that the disease is only important to few farmers (11.3%) in Kwale County (Machila et al., 2003). The pattern of parasitological prevalence in the different age groups, observed in Kwale County is not consistent with the findings of Desquesnes et al. (1999) who argued that older animals had more chances to be exposed to tsetse bites than younger ones. Most cattle of our study site graze and water close to Shimba Hills National Reserve where they come into contact with tsetse flies. The higher parasitological prevalence of bovine trypanosomosis observed in the County could be attributed to the higher trypanosome challenge around the National park which was subjected to annual re-invasion.

On the basic of the PCV readings, an assumption can be made on the infection status of animals with trypanosome. According to Stephen (1986), anaemia which is best measured by PCV, remains one of the indicators of trypanosomosis in cattle. In the present survey, 68.2% of positives animals showed PCV values of >24% which is beyond the benchmark (Kelly, 1967), using parasitological technic. This finding can be explained by the fact that the microhaematocrit buffy coat technique of detecting trypanosomes in the blood is more sensitive, than that of direct smear examination for example (Paris et al., 1982). Earlier reports on the evaluation of the sensitivity of different diagnostic tests have shown to be, in decreasing order, that of microhaematocrit > thick blood smear > thin film > wet film (Luckins, 1988). The low PCV values of trypanosomosis positive cattle is in agreement with previous findings, which noted that the disease reduced PCV levels in infected animals (Losos and Ikeda, 1972). Similarly, cattle with high prevalence of trypanosomosis have low haematocricrit levels (Mahama et al., 2004). However, other observations suggest that average herd PCV values are affected by other factor other than trypanosomosis (Connor, 1994). Poor nutrition is known to result in low PCV (Katunguka-Rwakishaga et al., 1995). Other causes include fasciolosis or haemonchosis (Zinsstag et al., 1998).

Result of tsetse and biting flies apparent densities confirm earlier findings by Ohaga et al. (2007) which observed that G. austeni, G. brevipalpis, G.

pallidipes and biting flies were present in the survey area. Great variability in tsetse apparent densities observed by location could be explained by the fragmentation of tsetse habitat along riparian vegetation as described by Rocque et al. (2001). Although variations in humidity and temperature between dry and rainy season could have influenced tsetse fly population density from one location to another. It also should be noted that the vast and systematical use of trypanocidal drugs and the susceptibility of trypanosome populations to these drugs could have negatively confounded not only the conclusions drawn about the PCV values observed in the different cattle population but also about the prevalence of trypanosomosis in the County. Although resistance to trypanocidal drugs has been documented in Kwale County (Eisler et al., 2000) and others reports of drug resistance in other parts of West Africa (Clausen et al., 1992; Peregrine, 1994) suggest that this phenomenon should be taken into account when interpreting parasitological prevalence figures.

5. CONCLUSION

The study underscores the usefulness of crosssectional studies as a precursor to tsetse and trypanosomosis control interventions in the specific area. The results of the survey, besides identifying herds and villages where trypanosomosis constitutes a major problem, as far as animal health is concerned, also provided information on the prevalence of trypanosome species and strains as well as their vectors in the Kwale District. It is recommended that the District fulfill all the laid down criteria's to be chosen for a large scale field trial of tsetse repellent technology.

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PREVALENCE OF TRYPANOSOME INFECTIONS IN CATTLE AND TSETSE FLIES IN THE MAASAI STEPPE, NORTHERN TANZANIA.

PRÉVALENCE DES INFECTIONS À TRYPANOSOME CHEZ LES BOVINS ET LES MOUCHES TSE-TSE DANS LA STEPPE MAASAI (NORD DE LA TANZANIE)

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Abstract

African trypanosomosis is a disease of public health and economic importance that pose as a major threat to the livelihoods of the people living in the Maasai steppe, where there is significant interaction between the Maasai people, their livestock and various wildlife species. The vulnerability of the Maasai people to the disease is enhanced by the interaction of their cattle, which act as vehicles for trypanosomes, and tsetse flies. Therefore, this study was aimed at establishing the current status of the parasites circulating between cattle and tsetse flies in the area. The prevalence of trypanosome infections was obtained by PCR based molecular techniques performed on the DNA of 1002 cattle blood collected from five villages and 886 tsetse flies trapped within the Maasai steppe close to Tarangire National park. Overall prevalence of trypanosomes was 17.2% in cattle and 3.4% in tsetse flies. Seasonal analysis of the data revealed a higher prevalence of infections at the end of wet season compared to the dry and wet seasons. The PCR technique detected five trypanosome species which varied with season and location.

The magnitude and distribution of trypanosome infections both hosts were attributed to human activities associated with livestock movement and vector control. Analysis of T. brucei DNA using SRA-LAMP revealed no human infective trypanosomes. However, the prevalence of the trypanosome species and abundance of tsetse flies suggests the risk of spread to other animals and this further calls for continuous surveillance and disease.

Résumé

La trypanosomose africaine est une maladie d'importance économique qui constitue une menace majeure pour la santé publique, les moyens de subsistance des habitants de la steppe Maasai où se fait une interaction importante entre le peuple Masaï, son bétail et diverses espèces sauvages. La vulnérabilité des Maasaï par rapport à la maladie est accentuée par l'interaction de leurs bétails (qui servent de véhicules aux trypanosomes) et les glossines. Ainsi, cette étude visait à déterminer l'état actuel des parasites qui circulent entre les bovins et les mouches tsé-tsé dans cette zone. La prévalence des infections à trypanosomes a été obtenue par des techniques moléculaires basées sur la PCR effectuées sur l'ADN de 1002 échantillons de sang de bovins prélevés dans cinq villages et de 886 glossines piégées dans la steppe masaï située à proximité du parc national de Tarangire. La prévalence globale des trypanosomes était de 17,2% chez les bovins et de 3,4% chez les glossines. L'analyse saisonnière des données a révélé une prévalence plus élevée d'infections à la fin de la saison des pluies par rapport aux saisons sèche et humide. La technique PCR a permis de détecter cinq espèces de trypanosomes qui variaient selon la saison et le lieu.

L'ampleur et la distribution des infections à trypanosomes chez les deux hôtes ont été attribuées aux activités humaines associées aux mouvements du bétail et à la lutte antivectorielle. L'analyse de l'ADN de T. brucei à l'aide de tests SRA-LAMP n'a révélé aucun trypanosome infectant l'homme. Cependant, la prévalence des espèces de trypanosomes et l'abondance des glossines suggèrent le risque de propagation à d'autres animaux, ce qui demande une surveillance continue de la maladie.

Background

African trypanosomosis is a disease of public health importance that affects humans and animals. Animal African trypanosomosis (AAT) causes reduced production and animal losses leading to reduced economic growth [1, 2] of the Maasai people of northern Tanzania. The Maasai pastoralists depend mostly on livestock production for their livelihood, but trypanosomosis is a significant problem in the interface areas due to proximity to wildlife reservoirs. The distribution of African trypanosomosis corresponds to the distribution of tsetse

flies transmitting the disease [2, 3]. In Tanzania, Glossina spp. are widely distributed across the country especially in protected areas, game reserves, national parks and wildlife corridors such as the Maasai Steppe. Tsetse density has been shown to be high in the Manyara, Mara and Tanga regions of Tanzania, and Glossina morsitans is the most widely distributed tsetse fly species [4]. Subspecies of G. morsitans and G. fuscipes have been reported in western Tanzania while G. pallidipes and G. swynnertoni were reported to be most abundant in northern Tanzania [4, 5]. These species transmit trypanosomes of importance in Africa including T. congolense, T. suis, T. vivax, T. simiae, T. equipedum, T. evansi, T. godfreyi and T. brucei [3, 6, 7]. These species are widely distributed in animal and human hosts. They cause disease in a wide range of domestic animals including cattle, pigs, camels, goats, sheep, dogs, cats, horses and monkeys [6, 8, 9].

In East Africa, trypanosomosis has been endemic for a long time following a history of epidemics that occurred in the past [10]. In northern Tanzania, the long standing endemicity of the disease is due to ecological factors and vector biology that support the persistent circulation of trypanosomes [6, 11]. The ability of tsetse flies to transmit trypanosomes is facilitated by the environment in which the vectors interact with wildlife reservoirs and vulnerable populations in wildlife/livestock/human interface areas. Such an environment provides a suitable setting for transmission and spread of African trypanosomes [12]. The transmission of trypanosomes to susceptible animals and humans is further enhanced by climatic conditions and human activities associated with livestock movement and control regimes in the Maasai Steppe ecosystem [13–17]. Such practices maintain trypanosome circulation in vectors and livestock by creating carriers, which may not be detected in a population due to lack of clinical symptoms. However, molecular diagnostic techniques have made it possible to detect and identify infections even prior to the manifestation of the disease [6, 18]. The polymerase chain reaction has successfully been used for detection and characterization of infectious agents [19]. Several oligonucleotide primers have been developed to amplify trypanosome genes, some of which are generic or species-specific. The sensitivity of these primers has been reported previously [20–23].

Due to insufficient knowledge on the current status of trypanosomosis, there are no sustainable means or uniform vector control regimes suitable for interface areas, and this situation increases the vulnerability of humans and their livestock to trypanosomosis. Therefore, understanding of current infection status is key to providing the required knowledge for controlling African trypanosomoses appropriately. The aim of this study was to quantify trypanosome infections circulating in cattle and tsetse flies and understand their distribution and prevalence in livestock/wildlife interface areas of the Maasai Steppe, Tanzania.

Methods

Study area

The study was conducted in the Maasai Steppe of northern Tanzania, made up of Simanjiro plains, Tarangire National park and Lake Manyara National park [24]. It lies between 3°52' and 4°24'S and 36°05' and 36°39'E. The area has two rainfall seasons of spatial and temporal variation, comprising of short rains between October and December and long rains from February to May. The average temperature in the area is between 18 °C and 30 °C. The Maasai Steppe is made up of natural semi-arid ecosystem providing a home for a variety of animal species, vegetation, conducive temperature variations and rainfall, all of which support a natural habitat for vectors and various parasitic organisms [25]. Livestock and crop production are the main sources of livelihood in the Maasai Steppe with cattle production being the major activity [26]. Due to its proximity to the protected areas, the study area has the high interaction of wild, domestic animals and humans which increases circulation of trypanosomes through bites from tsetse flies, making trypanosomosis endemic in the area.

Study design

A repeated cross-sectional, observational study design was used in which three samplings were conducted. A multistage cluster sampling technique was used to select cattle whereby Lake Manyara and Tarangire National parks were used as land marks for the study. The sampling allowed a comparison of the magnitude of trypanosome infections between the end of wet (June 2015), dry (August 2015) and the beginning of wet (February 2016) seasons. Blood samples were collected from 1002 cattle in five villages (Fig. 1): Emboreet (n = 340), Loiborsiret (n = 200), Kimotorok (n = 200), Loiborsoit (n = 60) and Ortukai (n = 202). The five villages were selected based on their proximity to Tarangire National park, in the same areas where tsetse flies were captured. In each village, 50% of sub-villages were selected at random, and 50% of all bomas in each sub-village were selected systematically. A boma was taken as a sampling unit in which animals were selected at random. A boma is a traditional Maasai homestead, usually consisting of a number of huts surrounding an enclosure for livestock, especially cattle. The average number of cattle sampled per boma was seven, and a total of 94 bomas were selected. Sample size calculation was based on the assumption of a 95% confidence level, 27.5% expected trypanosome parasite prevalence, 0.05 tolerable error and a design effect of 1.2 for cluster sampling.

Blood sample collection and trapping of tsetse flies

Blood samples were taken from each animal by jugular venipuncture using 10 ml vacutainer tubes (Becton Dickinson Vacutainer Systems, Plymouth,

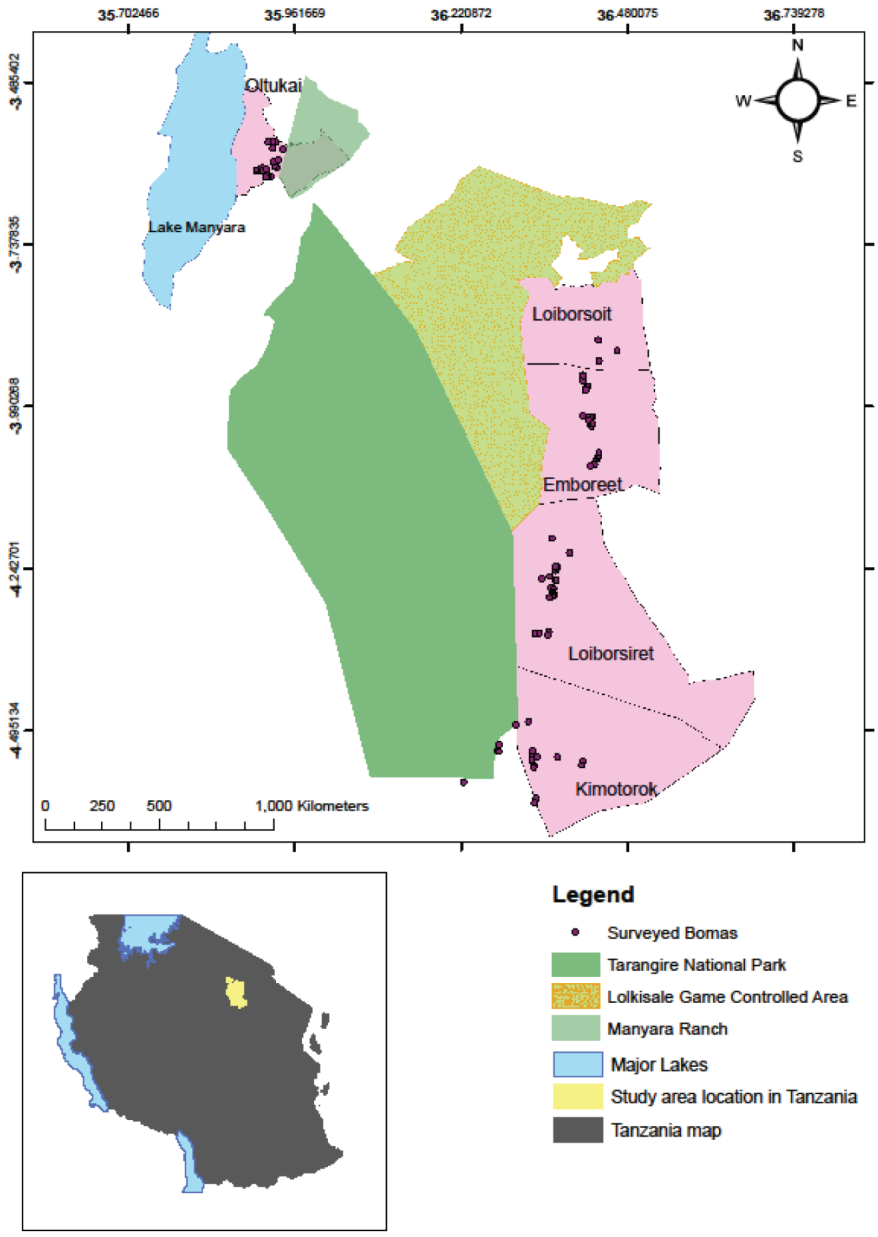


Fig 1: *Map showing the study villages in Simanjiro and Monduli districts of northern Tanzania*

UK) containing ethylenediaminetetraaceticacid (EDTA) anticoagulant. Blood samples were then kept in cool boxes on ice for 2–5 hours before refrigeration. The blood samples were further stored in a freezer at -20 °C until the day of DNA extraction.

A total of 886 tsetse flies were collected in June 2015 using Epsilon traps odour-baited with an attractant made from acetone, phenols and octanol. Traps were set at 27 sites in the study villages for a month, where they were checked and emptied every six days. Each trapped fly was kept in a separate Eppendorf tube with 70% ethanol at room temperature until DNA extraction.

DNA extraction

DNA was extracted from cattle blood as described in the protocol by Quick-gDNA blood mini prep kit (Zymo Research, Irvine, CA, USA). Ground tsetse flies were individually put in a ZR Bashing Bead™ Lysis Tube, and DNA was extracted using the protocol by ZR Tissue and Insect DNA Mini Prep, (Zymo Research). Fifty microlitres of DNA was eluted in Eppendorf tubes and stored at -20 °C until further analysis.

PCR identification of trypanosome species

A nested PCR was employed using two sets of primers comprising of outer forward (5'-GAT TAC GTC CCT GCC ATT TG-3') and reverse (5'-TTG TTC GCT ATC GGT CTT CC-3') primers, and inner forward (5'-GGA AGC AAA AGT CGT AAC AAG G-3') and reverse (5'-TGT TTT CTT TTC CTC CGC TG-3') primers [20, 22]. The nested PCR (nPCR) reaction was conducted in a 12.5 µl reaction comprising of 6.25 µl mastermix (Quick-Load Taq 2× Master Mix, New England BioLabs Inc., Ipswich, MA, USA), 2.5 µl DNA template, 3.25 µl nuclease free water and 0.2 µM of each first round primer. The second round amplification was performed using primers at the same concentration as the first round, 1 µl of the PCR products from the first round as a template and 4.75 µl of nuclease free water. Amplification conditions involved an initial denaturation step at 95 °C for 7 min followed by 35 cycles of denaturation at 94 °C for one min, an annealing step at 55 °C for one min, then extension step of 72 °C for two min and a final extension at 72 °C for 10 min. The PCR products were loaded on 1.5% agarose gel stained with GRGreen Nucleic Acid Stain (Excellgen, Inc., Rockville, MA, USA) and visualized on a Gel DocTM (Bio Rad, Hercules, CA, USA).

Additionally, a single step PCR for the identification of ITS 1 gene was used to compare the prevalence of trypanosome infections in cattle and tsetse flies. Briefly, primers with the following sequences were used: F: 5'-CCG GAA

GTT CAC CGA TAT TG-3' and R: 5'-TTG CTG CGT TCT TCA ACG AA-3' [27]. The reaction was performed in a 25 µl reaction volume containing 12.5 µl of mastermix (Quick-Load Taq 2× Master Mix, New England BioLabs Inc., Ipswich, MA, USA) containing DreamTaq DNA polymerase supplied in 2× DreamTaq buffer, 0.4 mM of each of the dATP, dCTP, dGTP and dTTP, and 4mM MgCl2, 0.2 µM of each of the forward and reverse primers, 6.3 µl nuclease free water and 5 µl DNA template. The reaction was conducted in a thermocycler (ProFlex PCR system, Applied Biosystems, Foster City, CA, USA) with an initial denaturation step of 94 °C for 3 min, followed by 30 cycles of 94 °C for 30 s, 55 °C for 30 s, 72 °C for 30 s and a final extension step at 72 °C for 10 min [28]. Expected fragment size for individual trypanosome species is shown in Table 1.

Table 1: *Expected band sizes of trypanosome species amplified by two methods*

Trypanosome species	ITS1 PCR (bp)	Nested ITS PCR (bp)
T. congolense Forest	710	1513
T. congolense savannah	700	1413
T. congolense kilifi	620	1422
T. brucei	480	1207–1224
T. simiae	400	850
T. vivax	250	611
T. theileri		988

SRA-LAMP for detection of human-infective trypanosomes

All T. brucei positive DNA from cattle and tsetse flies were subjected to SRA-LAMP technique to detect human-infective trypanosomes (T. b. rhodesiense) [29]. The technique was performed using the primer sequences shown in Table 2. SRA-LAMP was conducted in 25 µl reaction volume containing 2.5 µl of 1× Thermopol buffer, 5 µl of 0.8M betaine, 1 µl of 200 µM dNTPs, 1 µl of 0.2 µM F3 and B3 primers, 1 µl of 2 µM FIP and BIP primers, 1 µl of 0.8µM loop primers LB and LF, 1 µl of 8 U Bst DNA polymerase, 2 µl of DNA template and 7.5 µl of nuclease free water. Reaction conditions for the SRA-LAMP were set at 62 °C for 1 h in a GeneAmp® PCR system 9700 (Applied Biosystems, Foster City, CA, USA). The reaction was terminated by increasing the temperature to 80 °C for five min. The SRA-LAMP products were visualised through colour change after addition of 2 µl SYBR Green I. An orange colour indicated negative results while the colour change to green signified positive results. The SRA-LAMP products were confirmed by gel electrophoresis using 1.5% agarose gel prepared in 1× TBE and stained with 1 µl of 10 mg/ml ethidium bromide. The products were separated at 120 V for 30 min and visualised using Ultra violet trans-illuminator (UVDoc™ Merton, UK).

Data analysis

The prevalence of infections was estimated using frequency and contingency tables in Excel and Epi Info™ version 7.0 (CDC, Atlanta, GA, USA) statistical software. Comparative location and seasonal prevalence were estimated using contingency tables, and logistic regression where the Chi-square expected and P-values were obtained. The chi-square values were obtained by a test of independence and homogeneity of proportions between dependent (outcome) and independent (exposure) variables using Pearson uncorrected test. Chi-square was used when all expected values were greater than five while Mid-P values for two-way tables were obtained when at least one expected value (row total*column total/grand total) was less than five. All P-values for tables with zero values were obtained with the assumption that 0.5 was added. The P-values of the results were analysed (using P = 0.05 as a cut-off value) at 95% confidence intervals to indicate the level of uncertainty around the obtained values.

Results

Prevalence of trypanosome infections in cattle

The overall prevalence of trypanosome infections in cattle detected using the nested PCR assay (Fig. 2) was 17.2% (172/1002; 95% CI: 14.91–19.68) (Table 3).

Table 2: SRA-LAMP primer sequences

Primer	Primertype	Primer sequence (5'–3')
SRA-F3	F3	GCGGAAGCAAGAATGACC
SRA-B3	B3	TCTTACCTTGTGACGCCTG
SRA-FIP	FIP	GGACTGCGTTGAGTACGCATCCGCAAGCACAGACCACAGC
SRA-BIP	BIP	CGCTCTTACAAGTCTTGCGCCCTTCTGAGATGTGCCCACTG
SRA-LF	LF	CGCGGCATAAAGCGCTGAG
SRA-LB	LB	GCAGCGACCAACGGAGCC

Prevalence of trypanosome infections varied between the five different villages significantly (P = 0.0003). Thus, the highest prevalence was found in Loibor-soit-A village (35.0%) followed by Kimotorok (20.5%), whereas lowest prevalence (12.1%) was observed in Emboreet village. The differences in prevalence between Kimotorok and Emboreet (P = 0.009) as well as Loibor-soit-A and Emboreet (P < 0.0001) were significant. No statistical significance was however observed when the prevalence of trypanosome infections was compared between different age or sex groups, although a strong association between prevalence and age of the animal was documented ($\chi 2 = 32.91$, P =

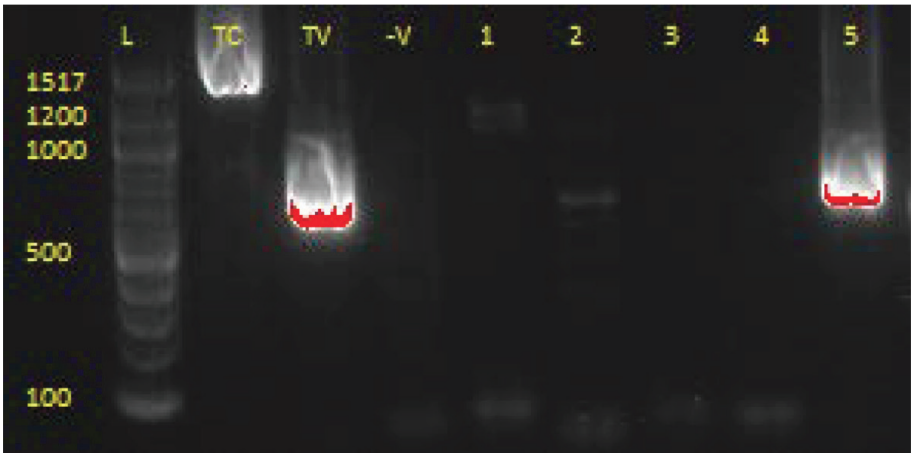


Fig. 2: *A gel picture of trypanosomes amplified using nPCR. Lane L: a 100 base pair (bp) DNA ladder; Lanes TC and TV: positive controls for T. congolense and T. vivax, respectively; Lane -V: negative control; Lanes 1–5: cattle DNA samples. Lane 1 shows a weak T. brucei-positive sample, Lanes 2 and 5 are T. vivax-positive samples and Lanes 3 and 4 are negative samples*

0.0631). Thus, highest prevalence (40.0%) was observed in cattle aged older than 10 years, whereas lowest prevalence (16.3%) was detected in cattle aged between 2 and 6 years and those younger than 2 years. Although infection prevalence was higher in female cattle (17.5%) than in males (16.4%), this difference was not statistically significant (Table 3).

Table 3: *Prevalence of trypanosome infections in the study population of cattle by village, age and sex*

Category	Sub-category	No. of cattle screened	No. of trypanosome infections	Prevalence (%)	$\chi 2$	P-value
Village	Emboreet	340	41	12.1	21.42	0.0003
	Kimotorok	200	41	20.5		
	Loiborsiret	200	36	18.0		
	Loibor-soit-A	60	21	35.0		

Category	Sub-category	No. of cattle screened	No. of trypanosome infections	Prevalence (%)	χ2	P-value
	Ortukai	202	33	16.3		
	Total	1002	172	17.2		
Age (years)	< 2	301	51	16.9	32.91	0.0631
	2–6	484	79	16.3		
	6–10	212	40	18.9		
	> 10	5	2	40.0		
	Total	1002	172	17.2		
Sex	Female	716	125	17.5	0.15	0.6977
	Male	286	47	16.4		
	Total	1002	172	17.2		

Abundance of single and mixed trypanosome infections in cattle

A total of 239 trypanosome infections were scored in the 172 positive cattle. While most cattle were infected with single trypanosome species (115/172 cattle; 66.9%), 27.9% (48/172) of the trypanosome-infected cattle carried multiple infections with two trypanosome species, 4.7% (8/172) carried three trypanosomes, and one animal (1/172; 0.6%) was infected with four trypanosome species. The most frequent multiple infections were T. vivax/T. simiae occurring in 12.8 % (22/172) of infected cattle followed by T. brucei/T. vivax (5.2%; 9/172). Trypanosoma vivax was the most abundant species (100/239), followed by T. brucei (50/239), T. simiae (47/239), T. theileri (24/239) and T. congolense (18/239). Trypanosoma vivax was the most abundant in all villages except in Loibor-soit-A, where T. brucei was most abundant. The distribution of these species by the village is as shown in Fig. 3. The highest number of trypanosome infections was documented in Kimotorok village (68/239), while least infections were found in Loibor-soit-A (26/239).

Seasonal distribution of trypanosome infections

The overall prevalence of trypanosome infections in cattle was higher at the end of wet season (18.7%) than at the beginning of the wet season (16.5%) or in the dry season (16.0%). The seasonal variation was not statistically significant neither when the overall cattle population was considered nor when the cattle were split by village (Table 4). However, a significant seasonal variation of prevalence of individual trypanosome species was obtained when T. brucei and T. theileri were analysed (P = 0.025) (Table 5).

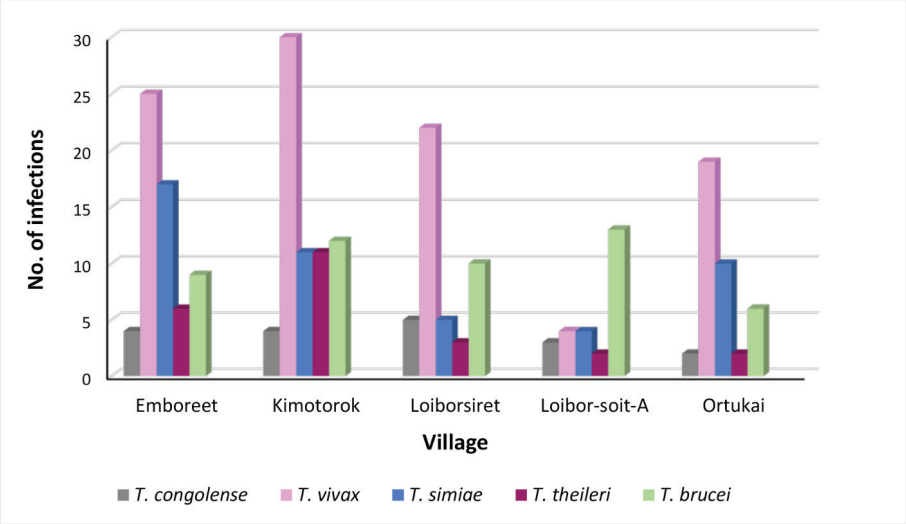


Fig. 3: *Spatial distribution of trypanosome species in the Masaai Steppe*

Table 4: *Seasonal variation of trypanosome infections in cattle*

Season	No. of cattle	Prevalence of infection, n (%)	χ^2	P-value
Early wet	200	33 (16.5)	1.0731	0.5848
End of wet	402	75 (18.7)		
Dry	400	64 (16.0)		
Total	1002	172 (17.2)		

Table 5: *Distribution of trypanosome infections across seasons*

Species	Total no. of infections	No. of infections (%)			χ^2	P-value
		End of wet season	Dry season	Beginning of wet season		
T. vivax	100	11.9 (48)	10 (40)	6 (12)	5.25	0.072
T. congolense	18	2.49 (10)	1 (4)	2 (4)	2.58	0.275
T. brucei	50	5.47 (22)	3 (12)	8 (16)	7.36	0.025
T. simiae	47	6.22 (25)	4 (16)	3 (6)	3.81	0.149
T. theileri	24	3.98 (16)	1.5 (6)	1 (2)	7.36	0.025

Prevalence of trypanosomes in cattle and tsetse flies

Trypanosome infections were concurrently studied in cattle and tsetse flies in order to determine the variation of prevalence spatially and seasonally. Table 6 shows the spatial variation in the two hosts and Fig. 4 shows the bands obtained using ITS 1 single PCR.

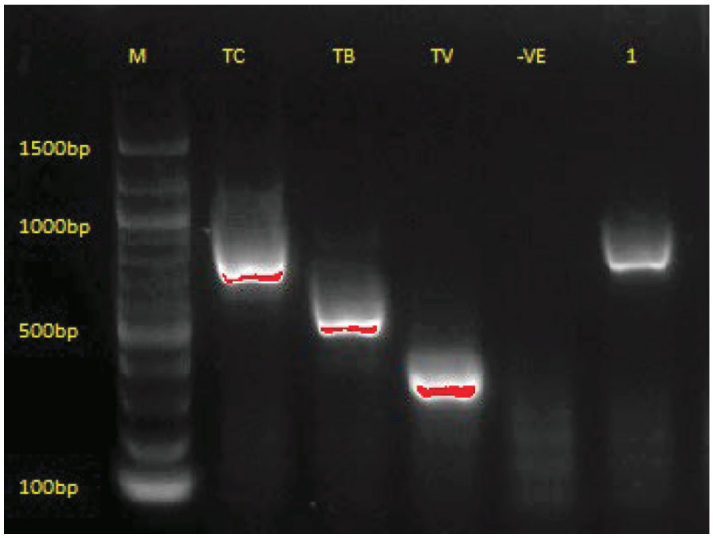


Fig. 4: *A gel of ITS1 single PCR. Lane M: DNA marker; Lanes TC, TB and TV: positive controls for T. congolense, T. brucei and T. vivax, respectively; Lane -VE: negative control; Lane 1: positive sample of T. congolense (700 bp)*

Table 6: *Trypanosome prevalence in cattle and tsetse flies*

Village	Cattle		Tsetse flies		P-value
	No. screened	No. of infections (%)	No. screened	No. of infections (%)	
Emboreet	100	13 (13.0)	72	10 (13.9)	0.8658
Kimotorok	100	21 (21.0)	9	0 (0)	0.1340
Loiborsiret	100	10 (10.0)	750	20 (2.7)	0.0016
Ortukai	102	10 (9.8)	55	0 (0)	0.0114
Total	402	54 (13.4)	886	30 (3.4)	< 0.0001

The overall prevalence of trypanosomes using a single step PCR for the ITS 1 gene was significantly higher in cattle (13.4%) than in tsetse flies (3.4%) ($P < 0.0001$) (Table 5). However, when prevalence in cattle and tsetse flies was examined in individual villages, a different trend was shown in different villages. For example, in Emboreet village the prevalence of trypanosomes was high in tsetse flies (13.9%) but slightly lower in cattle (13.0%) whereas in Kimotorok village, a 0% prevalence was shown in tsetse flies but 21.0% prevalence in cattle. Trypanosoma vivax was the most prevalent infection in tsetse flies (21/30; 70.0%) compared to that of T. brucei (6/30; 20.0%) and T. congolense (3/30; 10.0%). None of the tsetse flies collected during this period had mixed trypanosome infections, and none of the T. brucei positive DNA was positive for human-infective trypanosome species (T. b. rhodesiense).

Discussion

This study established a 17.2% prevalence of trypanosome infections in cattle in the selected villages of the Maasai Steppe. The prevalence reflects trypanosome infections in cattle regardless of their clinical status at the time of sampling. The prevalence level further indicates the potential risk for pastoral cattle to suffer from trypanosomosis and spread the infections to other animals through tsetse fly bites. This prevalence is higher than the 5% reported by others [30] using parasitological (microscopy) methods to detect active disease in the same area. One of the reasons behind the difference in the prevalence is the sensitivity of PCR compared to microscopy in the detection of trypanosomes. Further, PCR detects both clinical and subclinical infections which include pathogenic and non-pathogenic trypanosomes. Only cattle infected with pathogenic trypanosomes would show clinical signs depending on the virulence of the infecting species involved. For example, cattle infected with T. congolense are more likely to show clinical signs than cattle infected with T. theileri [6, 31, 32]. The 17.2% prevalence of trypanosome infections reported in this study also reflects the high trypanosome transmission intensity in livestock-wildlife interface areas, as may be expected in the Maasai Steppe ecosystem (Fig. 1), Several other studies have also reported a similar prevalence using PCR methods [21, 33, 34].

The present study compared the prevalence of trypanosome infections in different age groups of cattle. Higher prevalence of trypanosome infections was shown in cattle that were older than 2 years compared to younger ones, although the difference between age groups was not significant. Interestingly, a high strength of association was shown between age and infection prevalence ($\chi 2 = 32.9$). This finding was expected since older cattle grazed in tsetse fly infested areas whereas younger animals grazed close to homesteads, hence their lower exposure to tsetse bites. Our study has shown a significant variation of prevalence of trypanosome infections between villages. The variation may be ascribed to differences in community practices for vector control between

villages as well as livestock movement often towards protected areas with high abundance of wildlife. Seasonal livestock movement from one village to another in search of pasture and water is a common phenomenon in the Maasai Steppe, and such movements are expected to influence the prevalence of trypanosome infections. Furthermore, the movement of cattle herds increases their interaction with tsetse flies and wildlife through shared grazing fields and hence the potential for disease transmission between wild and domestic hosts [5]. Thus vector control is essential to cattle in these areas especially in villages like Loiborsoit-A where the prevalence of trypanosomes was high, and Kimotorok and Loiborsiret which are closest to Tarangire National park. The most common vector control method in the Maasai Steppe is the use of acaricide sprayers, which is not very cost-effective and is labour intensive. The ideal method would be to use dip tanks most of which are not functional due to structural damage and water shortage to refill the tanks. However, regular dipping of cattle before and after seasonal livestock movements to highly infested areas is essential [35, 36], what will complement already existing community-level vector control strategies and hence reduce trypanosome infections.

We have shown that the overall prevalence of trypanosome infections was higher at the end of wet season (18.7%) than during the dry and beginning of wet seasons. However, the seasonal variation was not significant. The non-significant overall variation of trypanosome infections could be due to chronicity of the parasites what can potentially lead to persistent trypanosome infections across seasons [37]. However, when individual trypanosome species were considered, significant seasonal variation was shown between T. brucei (whose prevalence was higher at the beginning of the wet season) and T. theileri. The variation of individual trypanosome species could also be due to biology and epidemiology of tsetse flies transmitting individual parasites. For example, Glossina morsitans is a good vector for T. congolense [38] while G. pallidipes, G. morsitans and G. swynnertoni are efficient vectors for T. brucei [5, 39]. Trypanosoma theileri is not dependent on the tsetse fly distribution but that of Tabanid flies [8]. In the Maasai Steppe, cattle come into close contact with the vectors either during normal grazing or movement due to seasonal changes in pasture availability. Another reason explaining the seasonal variation of the different trypanosome species is the potential mechanical transmission component of T. congolense and T. vivax, whose transmission is also dependant on tabanid and Stomoxys flies [40].

This study identified both pathogenic and non-pathogenic trypanosomes in cattle. The most prevalent trypanosome species was T. vivax which comprised 41.8% (100/239) of the overall infections. The abundance of T. vivax is consistent with its transmission pattern giving it more chances of infection in cattle. The high abundance of T. vivax and T. brucei could explain

the persistent subclinical infections exhibited by cattle in the Maasai Steppe [41], compared to less prevalent infections by pathogenic T. congolense as suggested by our study.

We report that 33.1% (57/172) of trypanosome positive cattle harboured mixed infections of two up to four trypanosome species. Mixed infections in mammalian hosts increase utilisation for nutrients and immune components due to competition for space and resources by trypanosomes leading to clinical implications on the host. This finding suggests that cattle in such endemic areas like the Maasai Steppe go through rounds of infection and re-infection with different trypanosome species, hence the persistence and chronicity of infections. Further, local cattle breeds may have adapted to live with low doses of trypanosomes in their blood without showing any signs of infection. However, this does not exempt them from getting multiple trypanosome infections. Another reason behind the occurrence of mixed trypanosome infections is the ability of tsetse flies to carry more than one species of trypanosomes. This is attributed to the different developmental predilection sites of trypanosome species. For example, T. congolense develops in the midgut while T. vivax develops entirely in the proboscis. This means that one tsetse fly can transmit more than one trypanosome species [42]. In the present study, we found T. vivax/T. simiae combination as the most frequent mixed infection which appeared in 26.4% of the positive cattle in all five villages. Trypanosoma simiae is considered not infective for cattle and therefore not pathogenic in cattle but very pathogenic to pigs. The presence of this species in cattle is not a common finding but has been reported before [32, 43]. The impact of the presence of this trypanosome species on the epidemiology of the disease is unclear so far although it suggests that pigs could be at risk of infection if exposed to both T. simiae-infected cattle and tsetse flies. However, most Maasai people do not rare pigs and as such this risk may not be anticipated. Mixed infections by pathogenic strains would lead to the manifestation of clinical signs in an infected host while infection by non-pathogenic species would result in chronicity of sub-clinical infections [44]. The mixed trypanosome infections in cattle reported here are comparable to those found in tsetse flies [45], where T. vivax/ T. simiae/ T. brucei was most abundant.

As expected, the overall prevalence of trypanosome infections was lower in tsetse flies than in cattle mostly because one tsetse fly can transmit trypanosomes to more than one animal. This finding could also be due to the fact that majority of trapped tsetse flies are comprised of unfed flies [46, 47], which normally have a lower chance of carrying trypanosome infections. The epsilon traps used in this study are known to be selectively specific to savannah tsetse flies (G. pallidipes and G. morsitans) and hence may leave out other tsetse fly species responsible for transmitting some species of trypanosomes

[48-50]. Nevertheless, the prevalence of trypanosome infections in tsetse flies found in this study was higher than the previously reported values [51] and [5] in the same study area. Higher infection prevalence in cattle, however, is due to the fact that cattle undergo multiple tsetse fly bites and each biting tsetse fly can transmit infections to several hosts giving cattle a higher prevalence of infections. On the other hand, the prevalence of trypanosome infections in cattle and tsetse flies reported for individual villages shows an inconsistent relationship, suggesting that high infection rates in flies do not necessarily mean high prevalence of trypanosomes in cattle (Table 6). This finding is most likely associated with human activities such as livestock movements, vector and disease control practices, which in the Maasai Steppe can be unpredictable. These findings entail that infections vary with time of the year (season) and location. This study also established a zero prevalence of mixed trypanosome infections in tsetse flies as opposed to the results reported by others [5, 45]. This finding could have been momentary considering that the study was conducted within a period of one month (June). An intensive or temporal study of mixed infections in tsetse flies could yield more information. However, the absence of mixed infections in this study could also be attributed to self- regulation and inhibition that takes place in the vectors [52]. The variation of trypanosome infections between cattle and tsetse flies could guide the Maasai pastoral communities living in tsetse fly infested areas when to control the disease strategically. The current study also showed no human-infective trypanosomes in both cattle and tsetse flies. These results are comparable to other studies conducted in the same area by others [5, 41, 51] who found no human-infective trypanosomes in northern Tanzania. Other studies have reported the presence of human-infective trypanosome in areas close to our study area [11]. The absence of circulating human-infective trypanosomes in the study area does not, however, call for relaxed control and surveillance, since the presence of reservoir hosts signifies an existing risk of emergence of the human-infective trypanosomes. Thus our study emphasizes the importance of enhanced control efforts by integrating the use of tsetse fly traps, chemotherapeutic and chemoprophylactic drugs that control the prevalent trypanosome species (including T. brucei), on livestock to maximize vector control in areas where tsetse flies are most abundant.

Limitations of the study

As much as ITS 1 primers produced baseline results for trypanosome infections, they amplified only 3 species of trypanosomes (T. congolense, T. brucei and T. vivax) and rarely showed mixed infections under our laboratory conditions. This could be one of the reasons for zero prevalence of mixed infections in tsetse flies. On the other hand, ITS nested primers yielded higher fragment resolution. However, the nested PCR also produced fragments which are not among the listed sizes for trypanosome species. Such fragments may represent novel trypanosome species, and further studies on these fragments are in progress to clarify the identity of these putative bands.

Conclusions

In summary, this study has established the seasonal and spatial prevalence of trypanosome infections in cattle and tsetse flies in villages in Simanjiro and Monduli districts of the Maasai Steppe. Age, sex and season did not significantly influence the prevalence of trypanosome infections. However, the location of the villages in relation to proximity to wildlife showed positive influence on the prevalence of trypanosome infections, with a high number of cattle carrying mixed trypanosome infections. This study has evidenced the circulation of five trypanosome species and factors that influence their occurrence. Factors such as geographical distribution of all trypanosome species and tsetse flies can be used as a guide to improved control measures. The knowledge and awareness of trypanosome infection distribution will enhance concrete human based control measures by the Maasai communities. These findings can also help strengthen trypanosomosis control measures at regional and national levels through implementation of active surveillance systems.

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Ethics approval and consent to participate

Ethical clearance (NIMR/HQ/R.8c/Vol.11/428) for the study was obtained from National Institute for Medical Research in Tanzania, and verbal consent was obtained from livestock owners during data collection.

Consent for publication

Not applicable.

Availability of data and material

The datasets generated and/or analysed during the current study are not publicly available because they are to be used for subsequent publications but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

MS and PSG designed the study and wrote the draft and final version of the manuscript. MS and LPS collected data and conducted laboratory analysis. PSG and SIK supervised MS throughout the research and manuscript writing. AN and HN collected tsetse flies and MN coordinated field activities. All authors read and approved the final manuscript.

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DÉTERMINATION DE LA PRÉVALENCE DES ESPÈCES DE TRYPANOSOMES AFRICAINS CHEZ LES CHIENS INDIGÈNES DU DISTRICT DE MAMBWE DANS L'EST DE LA ZAMBIE PAR LA TECHNIQUE LAMP (LOOP-MEDIATED ISOTHERMAL AMPLIFICATION)

DETERMINATION OF THE PREVALENCE OF AFRICAN TRYPANOSOME SPECIES IN INDIGENOUS DOGS OF MAMBWE DISTRICT, EASTERN ZAMBIA, BY LOOPMEDIATED ISOTHERMAL AMPLIFICATION

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Résumé

Contexte : Les chiens sont impliqués dans l'échange de parasites entre les animaux et les humains et restent une source importante de maladies émergentes et réémergentes, y compris les infections à trypanosomes. Pourtant, la trypanosomose canine africaine (CAT), en particulier chez les chiens indigènes, reste sous-déclarée. Nous avons évalué la performance de la technique LAMP (loop-mediated isothermal amplification) dans la détection de trypanosomes dans le sang provenant de chiens indigènes du District de Mambwe infesté de glossines, dans l'Est de la Zambie. Méthodes : Une étude transversale de la CAT a été menée dans 5 chefferies (Msoro, Kakumbi, Munkanya, Nsefu, Malama) du District de Mambwe en octobre 2012. Des échantillons de sang de 237 chiens ont été collectés et examinés par microscopie et LAMP. Résultats: Vingt chiens avaient des résultats positifs par LAMP 20 (8,4%, IC 95% : 4,9 à 12,0%) et seulement 14 par microscopie (5,9%, IC 95%: 2,9 à 8,9%). Les infections ont été causées par Trypanosoma congolense, T. b. Brucei et T. b. Rhodesiense zoonotique. Bien que les cas ne manifestent généralement pas de maladie clinique, l'apparition d'une opacité de la cornée a été associée à une infection d'une sous-espèce de T. brucei.

Conclusions : Compte tenu des cas sporadiques de réémergence de la THA signalés dans la vallée de Luangwa, la détection du gène associé résistant au sérum humain (SRA) chez les chiens indigènes témoigne du risque de THA pour les communautés locales et les touristes dans le District de Mambwe.

Abstract

Background: Dogs have been implicated in parasite exchange between livestock and humans and remain an important source of emerging and re-emerging diseases including trypanosome infections. Yet, canine African trypanosomosis (CAT), particularly in indigenous dogs remains underreported. We evaluated the performance of loop-mediated isothermal amplification (LAMP) in detecting trypanosomes in blood from indigenous dogs of tsetse-infested Mambwe district, eastern Zambia. Methods: Across sectional survey of CAT was conducted within 5 chiefdoms (Msoro,Kakumbi, Munkanya, Nsefu, Malama) of Mambwe district in October 2012. Blood samples from 237 dogs were conveniently collected and screened by microscopy and LAMP. Findings: Twenty dogs tested positive by LAMP 20 (8.4%; 95% CI: 4.9 – 12.0%) and only 14 by microscopy (5.9%; 95% CI: 2.9 – 8.9%). The Infections were caused by Trypanosoma congolense, T. b. brucei and zoonotic T. b. rhodesiense. Although the cases generally didn't manifest clinical illness, occurrence of corneal opacity was associated with T. brucei subspecies infection. Conclusions: In view of the sporadic cases of re-emerging HAT being reported within the Luangwa valley, detection of the human serum resistant associated (SRA) gene in indigenous dogs is indicative of the risk of contracting HAT by local communities and tourists in Mambwe district.

Background

In almost all societies, dogs are widely utilised and offer several benefits to humans, with the main one being security [1]. However, from a public health perspective, dogs have been sources of zoonotic parasites [2,3]. As such, dogs have served as a link for parasite exchange among livestock, wildlife and humans, and remain an important source of emerging and re-emerging infectious diseases[4,5].

In tsetse-infested sub-Saharan African countries, pathogenic protozoan trypanosome species are transmitted to a wide range of susceptible mammalian hosts, including dogs, through infective tsetse fly (Glossina) bites when taking blood meals [6,7]. Specifically, dogs are affected by Trypanosoma congolense, Trypanosoma evansi and Trypanosoma brucei subspecies [8-10], causing canine African trypanosomosis (CAT). In exotic breeds of dogs, T. brucei subspecies tend to cause acute CAT [5] while infections caused by T. congolense appear to be more chronic [5,9,11]. According to Abenga et al. [6], indigenous dog breeds in tsetse-infested regions of sub-Saharan Africa seem to be trypanotolerant. Although such dogs get infected with trypanosomes, they either exhibit subclinical signs or may not exhibit any overt clinical signs of the disease at all. Consequently, such dogs may also act as sources of infection to other domesticated animals and, more importantly, those with the humaninfective T. brucei rhodesiense and T. brucei gambiense may serve as a

source of infection for humans [5,8,11-13].

In our recent communication on CAT in exotic dog breeds [5], we reported for the first time in Zambia the occurrence of CAT caused by T. congolense and T. brucei subspecies. Through the use of LAMP, we had observed that some dogs were infected with the human-infective T. b. rhodesiense, suggesting their potential to act as sources of HAT. Two of the dogs had contracted CAT from the tsetse-infested Mambwe district in eastern Zambia, with one of them testing positive for T. b. rhodesiense infection.

To further address the paucity of data on CAT, we extended our investigations in this study to a relatively larger sample size of indigenous dogs, within the vicinity of South Luangwa National Park (SLNP) in the 5 chiefdoms of Mambwe district, namely Msoro, Kakumbi, Munkanya, Nsefu and Malama. We further evaluated the performance of the trypanosome species-specific LAMP, using parasite DNA obtained from the indigenous dog blood samples, against the gold standard microscopy.

Methods

Study site and design

During the month of October 2012, a cross sectional survey of CAT involving a total of 237 indigenous dogs was conducted in 47 villages within 5 chiefdoms (Msoro, Kakumbi, Nsefu, Munkanya, Malama) of Mambwe district.

The mongrels comprised 128 males and 109 females, most of which were hunting dogs aged between 3 months and 16 years. Mambwe district is situated in the eastern province of Zambia along the Luangwa valley, which supports a high density of tsetse flies and is a historic HAT focus. It lies within Lupande game management area (GMA) between latitudes 10° and 15° South and longitudes 30° and 33° East [14] adjacent to SLNP and is a popular tourist destination.

Sample collection and microscopy

Blood samples were conveniently collected from indigenous dogs whose owners consented to participate in the survey. Each participating dog was clinically examined and its body condition scored as described by [15]. Datum specific for each dog was captured on record sheets. About 2 ml of blood was drawn from the cephalic vein of each dog into heparinised capillary tubes, packed cell volume (PCV) values determined and Giemsa-stained thin blood smears from each dog examined as described [16]. In addition, about 200 µl

of each blood sample was placed on a labeled FTA® Elute card (Whatman FTA® Elute Cards, Whatman, UK) for DNA extraction according to the manufacturer's suggested protocol. All the participating dogs in this study were freely vaccinated against rabies.

DNA extraction and loop-mediated isothermal amplification DNA was extracted from dog blood samples and used for the LAMP assay as described by Namangala et al. [5], using specific primers targeting the 18S rRNA gene of T. congolense (CON2-LAMP) [17], the repetitive insertion mobile element (RIME) gene of the Trypanozoon subgenus group (RIME-LAMP) [18] and the human serum resistance-associated (SRA) gene uniquely expressed by T. b. rhodesiense (SRA-LAMP) [19], respectively. All RIME-LAMP positive samples were screened for T. b. rhodesiense using SRA-LAMP. Samples that were RIMELAMP positive and SRA-LAMP negative were considered to be T. b. brucei.

Data analysis

The captured data were entered, stored and statistically analysed using STATA version 11.0. Mean PCV values in trypanosome infected and non-infected dogs were compared using the one-way analysis of variance. The Fisher's Exact test was used to determine whether an association existed between the outcome variable (microscopy and LAMP results) and categorical variables under consideration (risk factors and clinical signs). Fisher's Exact test was used in the place of the chi squared test due to the small frequencies in some of the categories tested. Binary logistic regression was used to determine the true predictors of being positive for CAT by microscopy and LAMP.

P values <0.05 were considered statistically significant and only variables with significant Fishers exact test p-values were further analysed using univariable logistic regression. Based on their potential biological significance, a number of factors that included; chiefdom, age, body condition, vision, mucous membranes and the practice of hunting were entered into a multivariable logistic regression model. The multivariable model was constructed by first including all variables that passed the initial screening and then dropping variables manually in a backwards elimination procedure based on the likelihood ratio test. Only variables that were still significant at 5% level in the likelihood ratio test were retained.

Ethical clearance

Approval to conduct this study was granted by the University of Zambia Biomedical Research Ethics Committee under reference number 020-07-12.

Informed consent was sought from dog owners to participate in the survey and collect blood from their dogs.

Results

Clinical appearance of the examined indigenous dogs

Physical examinations revealed that a total of 31 (13.1%; 95% CI: 8.8 – 17.4%) out of the 237 dogs were emaciated, another 22 (9.3%; 95% CI: 5.6 – 13.0%) had pale mucous membranes. As observed by Bwalya et al. [20], most of the examined dogs in this study were also seen passing tapeworms and round worms in their stools during sampling. Furthermore, 55 dogs (23.2%; 95% CI: 17.8 – 28.6%) were infested with ecto-parasites, mainly ticks of Rhipicephalus species, predominantly found in the ears and inter digital spaces. About 24 dogs (10.1%; 95% CI: 6.3 – 14.0%) had enlarged superficial lymph nodes while 5 (2.1%; 95% CI: 0.3 – 4.0%) exhibited bilateral corneal opacity (Figure 1).

Detection of African trypanosomes by microscopy and LAMP

According to microscopy, 14 out of 237 mongrels (5.9%; 95% CI: 2.9 – 8.9%), were found to be infected with trypanosomes. All those 14 cases were also found to be positive for trypanosome infection by LAMP. Moreover, LAMP detected 6 additional CAT cases, bringing the total CAT cases detected by LAMP to 20 (8.4%; 95% CI: 4.9 – 12.0%), (Table 1). According to multivariable logistic regression analysis, the risk factors that seemed to influence the prevalence of CAT in indigenous dogs included location/chiefdom, (Odds ratio (OR) 6; 95% CI: 2.0 – 16.4; p = 0.002), vision (OR 18; 95% CI: 1.2 – 267.3; p = 0.037), age (OR 8.0; 95% CI: 1.0 – 61.1; p = 0.049) and illegal hunting (OR 2; 95% CI: 1.0 – 10.0; p = 0.049. Thus, although no CAT cases were recorded from Msoro and Kakumbi chiefdoms, Munkanya, Malama and Nsefu chiefdoms each recorded CAT prevalences of 18.0%, 16.7% and 8.8% by LAMP, respectively (Table 1). Adult dogs that were involved in hunting were more likely to acquire CAT than young dogs. In addition, although not statistically significant (p = 0.147), dogs that were positive for CAT tended to have lower PCVs (29 ± 9.4%; 95% CI: 23 – 32%) than those that tested negative (32 ± 8.7%; 95% CI: 31 – 33%).

According to LAMP, 13 mongrels (5.5%; 95% CI: 0.7 – 10.6%) were monolytically infected, 3 with T. congolense, 4 with T. b. brucei and 6 with T. b. rhodesiense, respectively. The other 7 dogs (2.9%; 95% CI: 0.6 – 5.9%) were coinfected, 2 with T. congolense and T. b. brucei and 5 with T. congolense and T. b. rhodesiense (Table 1). Among the infected dogs, 4 had corneal opacity (2 monolytic infections with T. b. rhodesiense; 1 monolytic infection with T. b. brucei; 1 co-infection with T. b. rhodesiense and T. congolense). Only 1 dog with corneal opacity tested negative for CAT. Analysis of data using Fisher's



Figure 1: *Clinical examination of an indigenous dog showing evidence of bilaterial corneal opacity.*

exact test revealed that CAT was significantly associated with corneal opacity. Accordingly, dogs with corneal opacity were 18 times more likely to harbour T. brucei subspecies than dogs with normal vision (OR 18; 95% CI: 1.2 – 267.3; p = 0.037).

The diagnostic accuracy of LAMP (index) was determined against microscopy (reference standard). As shown in Table 2, LAMP was found to be more sensitive and specific, and had a positive likelihood ratio (LR) of 37 and a negative LR of 0, suggesting that its use in CAT diagnosis could improve the management of this disease in endemic areas.

Discussion

The present study evaluated the performance of LAMP against the gold standard microscopy to detect trypanosomes in the blood collected from indigenous Mambwe mongrels in eastern Zambia. Whereas microscopy detected 14 CAT cases (5.9%), LAMP detected 20 CAT cases (8.4%) out of the 237 mongrels that were available for sampling in the present study, including all the 14 parasitologically positive cases, suggesting that LAMP is a reliable test. LAMP was found to have a positive likelihood ratio (LR) of

Table 1: *Prevalence of trypanosome species in indigenous dogs of Mambwe district, eastern Zambia, by LAMP*

Chiefdom	N° of dogs	Mean PCV (%) of infected dogs	Infected with					Overall prevalence of infection
			T. c	T. b. b	T. b. r	T. c + T. b. b	T. c + T. b. r	
Kakumbi	36	N/A	0 (0.0%) (0.0 – 0.0%)	0 (0.0%) (0.0 – 0.0%)	0 (0.0%) (0.0 – 0.0%)	0 (0.0%) (0.0 – 0.0%)	0 (0.0%) (0.0 – 0.0%)	0 (0.0%) (0.0 – 0.0%)
Malama	30	30 ± 14.1	0 (0.0%) (0.0 – 0.0%)	0 (0.0%) (0.0 – 0.0%)	3 (10.0%) (0.0 – 21.4%)	0 (0.0%) (0.0 – 0.0%)	2 (6.7%) (0.0 – 16.1%)	16.7% (2.5 – 30.8%)
Msoro	53	N/A	0 (0.0%) (0.0 – 0.0%)	0 (0.0%) (0.0 – 0.0%)	0 (0.0%) (0.0 – 0.0%)	0 (0.0%) (0.0 – 0.0%)	0 (0.0%) (0.0 – 0.0%)	0 (0.0%) (0.0 – 0.0%)
Munkanya	50	27.7 ± 8.4	2 (4.0%) (0.0 – 9.6%)	2 (4.0%) (0.0 – 9.6%)	1 (2.0%) (0.0 – 6.0%)	2 (4.0%) (0.0 – 9.6%)	2 (4.0%) (0.0 – 9.6%)	18.0% (7.0 – 29.0%)
Nsefu	68	32 ± 5.7	1 (1.5%) (0.0 – 4.4%)	2 (2.9%) (0.0 – 7.1%)	2 (2.9%) (0.0 – 7.1%)	0 (0.0%) (0.0 – 0.0%)	1 (1.5%) (0.0 – 4.4%)	8.8% (1.9 – 15.7%)
Total	237	29 ± 9.4	3 (1.3%) (0.0 - 2.7%)	4 (1.7%) (0.0 – 3.3%)	6 (2.5%) (0.5 – 4.5%)	2 (0.8%) (0.0 – 2.0%)	5 (2.1%) (0.3 – 4.0%)	8.4% (4.9 – 12.0%)

N/A: Not applicable; T. c: Trypanosoma congolense; T. b. b: Trypanosoma brucei brucei; T. b. r: Trypanosoma brucei rhodesiense.

37 and a negative LR of 0. According to Florokowski [21], a positive LR > 10 and a negative LR < 0.1 can exert highly significant changes in probability that is capable of altering clinical management. Our findings therefore show that the use of LAMP in CAT diagnosis could improve the management of this disease in endemic areas. Furthermore, LAMP was not only able to distinguish different trypanosome species such as T. congolense and T. brucei, but was also able to distinguish between closely related T. b. brucei and T. b. rhodesiense.

According to LAMP, about 35% of the CAT cases were co-infections, supporting the notion that many CAT infections in the field are caused by more than one trypanosome species [13]. Based on experimental findings in co-infected dogs, T. brucei subspecies are thought to dominate and interfere with T. congolense in establishing parasitaemia and subsequently their pathogenic effects [13]. In further agreement with previous reports [8,13], the presence of either T. b. brucei or T. b. rhodesiense infections in dogs was characterized by relatively higher parasitaemia and in some cases bilateral corneal opacity, unlike monolytic infections with T. congolense. As previously reported [8,11,13,22,23], the loss of vision in dogs due to corneal opacity seems to be associated with monolytic or mixed infections with T. brucei subspecies. Dogs with corneal opacity were 18 times more likely to be CAT infected than the dogs with normal vision (OR 18; 95% CI: 1.2 – 267.3; p = 0.037). Importantly, however, no association with corneal opacity was observed in monolytic infections with T. congolense in the present study. This may not be surprising as members of T. brucei subspecies, unlike T. congolense, can traverse the vascular tissue and cause damage to various extra-vascular tissues, including the eyes [5,8].

The present findings are consistent with those of other studies and further support the idea that LAMP tends to be more sensitive than microscopy [5,18,24,25]. LAMP has the advantage over other sensitive and specific molecular techniques such as polymerase chain reaction (PCR) in that it is simpler, more rapid and cheaper to perform, as it only requires a heating device for incubation and may therefore be performed even in the field [26,27]. Since our laboratory extracts DNA by simply boiling the Elute FTA disks at 95°C for 30 minutes (Whatman FTA® Elute Cards, Whatman, UK), we are in the process of preparing LAMP reagents that would conveniently enable us to conduct the assay in the field. Furthermore, the LAMP assay shows high tolerance to biological products such that DNA extraction may not be necessary [28]. Thus LAMP may be more practical for routine diagnosis of CAT and other neglected tropical protozoan diseases in resource-limited communities of sub-Saharan Africa where such infections are endemic[25].

Table 2: *Diagnostic accuracy of LAMP and microscopy*

	Microscopy		
	True positive	**False positive**	
LAMP-positive	(TP) = 14	(FP) = 6	TP + FP = 20
LAMP-negative	(FN) = 0	(TN) = 217	TN + FN = 217
Total	TP + FN = 14	TN + FP = 223	237

Note:

LAMP Sensitivity = TP / (TP + FN) = 100%.

LAMP Specificity = TN / (TN + FP) = 97.3%.

LAMP Positive predictive value (PPV) = TP / (TP + FP) = 70%.

LAMP Negative predictive value (NPV) = TN / (TN + FN) = 100%.

LAMP Positive likelihood ratio (LR+) = sensitivity / (1 – specificity) = 37.

LAMP Negative likelihood ratio (LR-) = (1 – sensitivity) / specificity = 0.

Our findings show that location (chiefdom), age and illegal hunting were significant risk factors that predisposed indigenous dogs to CAT. Out of the 5 chiefdoms surveyed, CAT was only detected in Munkanya (18.0%), Malama (16.7%) and Nsefu (8.8%) mainly among adult hunting dogs while no CAT cases were reported in Kakumbi and Msoro. The human-infective T. b. rhodesiense was detected in each of the 3 chiefdoms where CAT was reported. According to the predictive epidemiological theory, where the non-human-infective T. b. brucei and the human-infective T. b. rhodesiense subspecies co-exist, the prevalence of the latter should exceed that of the former [29]. In contrast, however, most field reports suggest the opposite to be true and show that T. b. brucei predominates in all domestic livestock [30]. Our data seems to be in conformity with the predictive epidemiological theory. In particular, the unusually high prevalence of the human-infective T. b. rhodesiense circulating in dogs from Malama chiefdom compared to the non-human-infective T. b. brucei is intriguing. Similarly, although the overall prevalence of the non-human-infective T. b. brucei reported by Hamill et al. [30] in northern Tanzania was higher than that of the human-infective T. b. rhodesiense, Arumeru district recorded unusually higher prevalence of the human-infective T. b. rhodesiense circulating in pigs. These data should be used to trigger a "One Health" approach towards HAT control through disease intervention in livestock [30]. On the other hand, however, the prevalence of the non-human-infective T. b. brucei in our study may be under-estimated considering the fact that our LAMP system is unable to identify dogs co-infected with T. b. rhodesiense and T. b. brucei. The difference in CAT distribution among chiefdoms may be as a result of (i) the proximity to SLNP, availability and abundance of tsetse flies and other haematophagous arthropods, (ii) the occurrence of larger domestic livestock which may be more preferable for tsetse feeding than the smaller

mongrels [14], (iii) the frequency of hunting by dogs, hence their chance of being bitten by tsetse flies, and (iv) the heavy presence of Zambia wildlife authority (ZAWA) personnel that monitor acts of illegal hunting in Kakumbi and Msoro chiefdoms. Thus, the fact that no domestic animals other than dogs are kept in Malama may partially explain the higher CAT prevalence, whereas the presence of livestock in wildlife zones [14] and the availability of veterinary services for dogs mainly in Kakumbi and Msoro may explain its absence.

In conformity with a recent report of CAT in exotic dogs [5], this research reports two main trypanosome species causing CAT in indigenous dogs, i.e. T. congolense and T. brucei subspecies. However, whereas T. brucei subspecies reportedly cause acute CAT in exotic dog breeds [5,8], no acute CAT was observed among indigenous Mambwe dogs. In fact, most of the CAT cases in this research did not manifest clinical disease other than corneal opacity in some cases. These data suggest that indigenous dogs in tsetse-infested regions such as Mambwe district may be relatively tolerant to trypanosome infections [5,6,8]. Ideally, those dogs should have shown more serious clinical signs considering the fact that most of them were malnourished, generally had poor body condition scores and never received veterinary services. Nonetheless, the majority of those dogs were either asymptomatic or only exhibited mild signs, with no cases of acute CAT. As such, they could serve as reservoirs of infection for other domestic animals and humans [5,22].

The detection of the SRA gene in trypanosomes isolated from 11 indigenous dogs in this study is a source of public health concern in view of the close relationship between dogs and humans. Matete [8] postulated that "sporadic and very low prevalence of human-infective trypanosomes in dogs closely reflects disease occurrence in humans". It is noteworthy that Anderson et al. [31] recently reported SRA positive trypanosomes in an African buffalo in Nyamaluma, within Malama chiefdom where we detected the same gene in trypanosomes from 5 indigenous hunting dogs. These findings indicate the risk of contracting HAT by the local communities, ZAWA officials and tourists. Indeed, unpublished confirmed sporadic cases of HAT have previously been reported in Mambwe district [32], with the most recent case involving a 21 year-old man from Munkanya chiefdom. Moreover, in 2008 alone, between the months of March and July, about 12 HAT cases involving ZAWA officials were reported in the Luangwa valley [33]. Furthermore, at least 6 HAT cases have been reported among tourists visiting SLNP since 2010 [34-36]. Collectively, these data suggest that HAT is re-emerging in the old foci within the Luangwa river valley [26,34-36].

Conclusions

Despite the many benefits indigenous dogs may offer to the local communities, our study findings show that dogs are potential links for tryapanosome exchange between livestock and humans. For instance, the detection of the SRA gene in trypanosomes from dogs from Zambia's Mambwe district indicates the risk of humans contracting HAT. Our study suggests that LAMP has a higher sensitivity and specificity than microscopy and is hence a more reliable test in detecting trypanosomes. In order to facilitate effective prevention and control measures of trypanosome infections, there is a need for continuous surveillance of the disease in tsetse-infested regions such as Mambwe district, using user-friendly and yet sensitive and specific tests such as LAMP. It is particularly important to sensitize the local community of the potential dangers of keeping dogs that are just left to scavenge without receiving any veterinary services in such a prohibited place like the GMA. Such dogs may harbour several other zoonoses in addition to T. b. rhodesiense, with potential serious implications to human health.

Abbreviations

CAT: Canine African trypanosomosis; HAT: Human African trypanosomiasis;

SLNP: South Luangwa national park; SRA: Serum resistance-associated gene;

GMA: Game management area; ZAWA: Zambia wildlife authority; LAMP: Loop-mediated isothermal amplification; RIME: Repetitive insertion mobile element; PCR: Polymerase chain reaction.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

ML helped to conceive the study, participated in its design, obtained funding, collected samples, performed microscopy, purified the DNA from dog blood on FTA elute cards, performed the LAMP Assays, analysed data and drafted the manuscript. MM, LM, and JN were involved in the purification of DNA from dog blood on FTA elute cards and performed the LAMP Assays. SN co-supervised the study and helped in editing the manuscript. BN supervised and helped to conceive the study, participated in its design, collected samples, performed the LAMP Assays and edited the manuscript. SC, KK and HK helped to conceive the study, participated in its design and assisted in obtaining funding. All the authors read and approved the final manuscript.

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DÉTECTION DE LA TRYPANOSOMIASE BOVINE REÉMERGENTE DANS LE SUD DE LA ZAMBEE PAR LA TECHNIQUE LAMP (LOOP-MEDIATED ISOTHERMAL AMPLIFICATION)

DETECTION OF RE-EMERGING BOVINE TRYPANOSOMIASIS IN SOUTHERN ZAMBIA BY LOOPMEDIATED ISOTHERMAL AMPLIFICATION (LAMP)

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Résumé

La trypanosomiase est une maladie tropicale négligée causée par les parasites du trypanosome, à savoir Trypanosoma congolense, le sousgenre Trypanozoon et Trypanosoma vivax. Elle est transmise par la mouche tsé-tsé (vecteur) dans les pays africains sub-sahariens, et affecte l'homme et les animaux. Dans la présente étude, la technique LAMP spécifique aux espèces de trypanosomes, spécifiquement ciblée sur le gène 18S rRNA de Trypanosoma congolense, le gène RIME (repetitive insertion mobile element) du groupe du sous-genre Trypanozoon et le gène SRA (human serum resistant associated) de Trypanosoma brucei rhodesiense, a été utilisée pour déterminer la prévalence de la trypanosomiase bovine dans le bloc Choma-Kalomo, une zone agricole importante dans la province méridionale de Zambie. Nos données montrent que sur les 460 bovins échantillonnés, 12,8% (IC 95%: 9,7-15,8%) avaient des trypanosomes dans leur sang par LAMP, 9,5% (IC à 95%: 2,0-17,0%) des infections étant causé par T. congolense et 2,4% (IC à 95%: 1,5 à 6,3%) par T. b. Brucei, et 0,9% (IC à 95%: 1,5-13,3%) étant une infection mixte de T. congolense et T. b. Brucei. T. b. Rhodesiense n'a pas été détecté dans ces échantillons.

Étant donné que LAMP est une technique très sensible et spécifique et pourtant conviviale, elle peut, à l'avenir, s'avérer utile dans la détection systématique précise de la trypanosomose dans des échantillons de terrain dans des pays à ressources limitées comme la Zambie.

Abstract

Trypanosomiasis is a neglected tropical disease caused by the trypanosome parasites namely Trypanosoma congolense, Trypanozoon subgenus and Trypanosoma vivax. It is transmitted by the tsetse fly vector in Subsaharan

African countries affecting both the humans and animals. In the present study, trypanosome species-specific Loop-mediated isothermal amplification (LAMP) technique, specifically targeting the 18S rRNA gene of Trypanosoma congolense, the repetitive insertion mobile element (RIME) gene of the Trypanozoon subgenus group and the human serum resistant associated (SRA) gene of Trypanosoma brucei rhodesiense, was used to determine the prevalence of bovine trypanosomiasis in the Choma - Kalomo block, an important agricultural area within the Southern province of Zambia. Our data show that out of the 460 cattle sampled, 12.8% (95% CI: 9.7-15.8%) were detected to have trypanosomes in their blood by LAMP, with 9.5% (95% CI: 2.0-17.0%) of infections being caused by T. congolense, 2.4% (95% CI: 1.5-6.3%) caused by T. b. brucei, and 0.9% (95% CI: 1.5-13.3%) being mixed infection of T. congolense and T. b. brucei. No T. b. rhodesiense was detected. Considering that LAMP is a highly sensitive and specific technique and yet user friendly, this test may in future prove to be instrumental in the routine accurate detection of trypanosomiasis in field samples in resource-limited countries such as Zambia.

Introduction

Bovine trypanosomiasis is one of the major constraints to sustainable livestock agriculture development in sub-Saharan Africa (SSA), especially in the traditional sector, which in the case of Zambia accounts for about 80% of the country's cattle population. The annual direct production loss due to bovine trypanosomiasis alone is in excess of US$10,000 million in the 37 tsetse-infected SSA countries (Hursey and Slingenberg, 1995). The majority of the cattle owned by resource-limited farmers are found in tsetse infested areas and are at risk of contracting trypanosomiasis (Coetzer et al., 1994).

Zambia lies within the 'common fly belt' shared together with Malawi, Mozambique and Zimbabwe, in which Glossina morsitans morsitans (G. m. morsitans) and G. pallidipes are the most abundant tsetse fly species (Van den Bossche and Vale 2000). The Zambian part of the common fly belt is mainly centered on the Luangwa valley and further extends to the Zambezi valley and the adjacent areas. The common fly belt has a large population of wildlife in game parks bordered by human habitats and domestic animals (Symeonakis et al., 2007). The Choma-Kalomo block is an area of approximately 4,500 km2 adjacent to the common tsetse fly-belt closer to the Kafue National Park (Lovemore, 1989). Livestock production is one of the livelihoods of peasant farmers in addition to crop production in the Choma-Kalomo agricultural block. However, vector-borne diseases such as trypanosomiasis theileriosis, anaplasmosis, babesiosis and heartwater negatively affect livestock production.

Diagnosis of Bovine trypanosomiasis remains unsatisfactory in most resource limited countries in Africa, resulting in poor control strategies of the disease. Currently, the commonly used diagnostic tools include traditional parasitological and serological methods. Loop-mediated isothermal amplification (LAMP) is a new molecular diagnostic method that rapidly amplifies target DNA under isothermal conditions (Notomi et al., 2000). LAMP has recently been developed for use in the diagnosis of several pathogens including animal pathogenic African trypanosomes (Kuboki et al., 2003; Thekisoe et al., 2005; 2007) and human pathogenic African trypanosomes (Njiru et al., 2004; 2008). Unlike other molecular techniques such as the polymerase chain reaction (PCR) which require costly equipment and highly skilled manpower, LAMP is relatively cheaper, requiring only a heating block or water bath and is easier to use. Furthermore, LAMP assays may be conducted within an hour and the products may be visualized by naked eyes (Notomi et al., 2000).

This study was carried out to determine the prevalence of bovine trypanosomiasis in Choma-Kalomo block located in the southern province of Zambia in which tsetse flies were previously eradicated. In 1987, this area was aerial-sprayed under the Regional Tsetse and Trypanosomiasis Control Programme (RTTCP). The overall objective of the RTTCP of Malawi, Mozambique, Zambia and Zimbabwe was to eradicate the tsetse flies from a discrete common fly-belt of approximately 322,000 km2 within the Zambezi valley and the adjacent areas in order to control trypanosomiasis (Connor, 1989). This successfully eradicated the tsetse flies in the area and led to improved cattle productivity and associated agricultural activities (Connor, 1989). Unfortunately, recent field reports from within the Choma-Kalomo block indicate a re-surgence of trypanosomiasis (Personal communication, Silawve, Southern Province Principle Biologist; Soko, Choma district Veterinary Officer). In this regard, there was need to conduct a systematic study to determine the prevalence of re-emerging trypanosomiasis in that important agriculture region.

Materials and Methods

Study area

A cross sectional study was carried out in the Choma-Kalomo agricultural block (Fig. 1) of the Southern province of Zambia in December 2009. The Choma-Kalomo block, approximately 4,500 km2 in size, is an agriculture zone which incorporates fairly large parts of Choma, Kalomo and a small section of Namwala and Itezhi tezhi districts. A total of 13 sampling sites were identified. Geo-spatial references of the selected crush pens were recorded (Table 1).

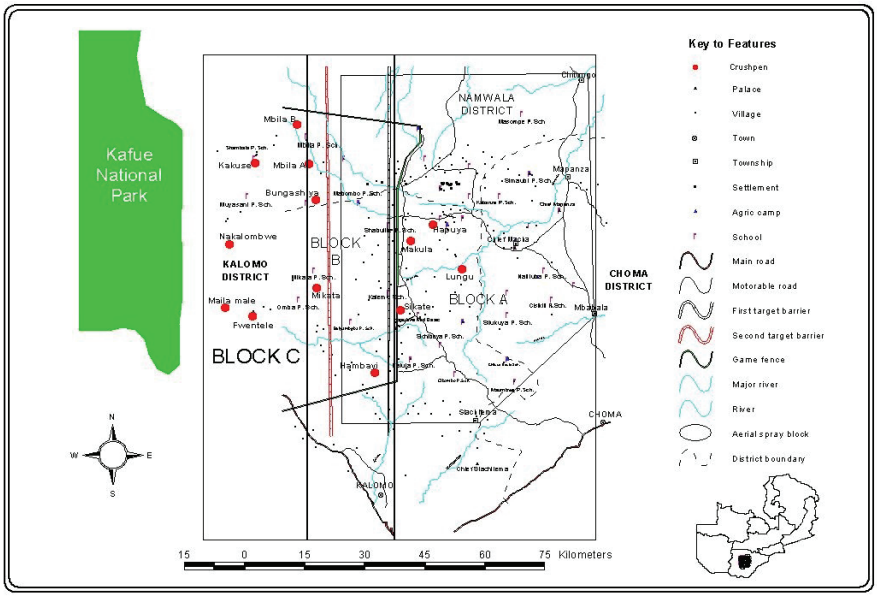


Figure 1: *The Choma-Kalomo agricultural block and the thirteen sampling site, crush pens (red pots). The Choma-Kalomo block is an area of approximately 4,500 km2 adjacent to the common fly-belt closer to Kafue National Park, Zambia. It incorporates fairly large parts of Choma, Kalomo and small sections of Namwala and Itezhi tezhi districts and is an important agriculture area.*

Table 1: *Location and geo-spatial references of selected crush pens as sampling site*

District	Veterinary camp	Crush pen name	Geo-spatial reference	
			Latitude	Longitude
Choma	Lungunya A	Lungu	S: 16.45846	E: 026.23309
		Hapuya	S: 16.27259	E: 026.31499
		Sikaate	S: 16.38766	E: 026.48587
		Makula	S: 16.38764	E: 026.43072
Itezhi tezhi	Basanga	Mbila A	S: 16.17338	E; 026.31499
		Mbila B	S: 16.22934	E: 026.33706
		Kakuse	S: 16.38676	E: 026.49305
Kalomo	Lungunya B	Hambayi	S: 16.43545	E: 026.38589
		Bungashiya	S: 16.36614	E: 026.14082
	Nkanda zovu	Mikata	S: 16.46427	E: 026.30394
		Fwentele	S: 16.55185	E: 026.13389
		Nakalombwe	S: 16.38044	E: 026.15285
		Maila Male	S: 16.49340	E: 026.15802

(Source: RTTCP, Zambia, 2002)

Sample collection

The number of cattle to be sampled was determined as described by Cannon and Roe (1982), with an estimated trypanosomiasis prevalence of 1%, confidence level of 95% and total cattle population of 75,000. This gave a minimum of 299 heads of cattle to be sampled. However, a total of 460 heads of cattle were sampled. A simple random sampling method was applied to systematically select animals at each of the 13 crush pens. From each animal, blood was collected from the superficial ear vein into two heparanised microhaemetocrit capillary tubes. The capillary tubes were sealed with "cristaseal" (Hawksley, UK) and centrifuged immediately in a haematocrit centrifuge. The buffy coat and uppermost layer of red blood cells of centrifuged heparinised microhaemetocrit capillary tubes of each specimen were extruded onto a labelled filter paper (Whatman no. 1, Whatman®) as buffy coat spot for extraction of trypanosomal DNA. The buffy coat spots were dried and kept in zip lock plastic bags containing silica gel at -20oC until DNA extraction. The above procedures were done in the field at the sampling site.

DNA extraction

DNA was eluted from three punched paper disks of dried buffy coat spots according to the modified methanol fixation method described by Johanson et al. (2009). The eluted DNA was stored at -200C until use.

Loop-mediated isothermal amplification

A LAMP reaction of 25 µl was performed using a Loopamp DNA Amplification Kit (Eiken Chemical, Tochigi, Japan) and the parasite DNA as template, according to the manufacturer's instructions, with minor modifications. Briefly, 3 µl of template DNA was added to a 22 µl master mix containing 12.5 µl of reaction buffer (40 mM Trish-HCl (pH 8.8), 20 mM KCl, 16 mM MgSO4, 20 mM (NH4)2SO4, 0.2% Tween 20, 1.6 M Betaine, 2.8 mM of each dNTP), 1 µl of Bst DNA polymerase enzyme (provided in the Loopamp DNA Amplification kit), 1 µl Loopamp fluorescent detection reagent (Eiken Chemical, Tochigi, Japan), 2 µl primer mix and 6.5 µl distilled water. This study made use of the recently designed primers specifically targeting the 18S rRNAgene of Trypanosoma congolense (Thekisoe et al., 2007), the repetitive insertion mobile element (RIME) gene of the Trypanozoon subgenus group (Njiru et al., 2008a) and the human serum resistant-associated (SRA) gene of Trypanosoma brucei rhodesiense (Njiru et al., 2008b), respectively. The primer mixes were made as follows: (i) CON2 18s rRNA gene of T. congolense (BIP and FIP at 40 pmol each, F3 and B3 at 5 pmol each); (ii) RIME gene of Trypanozoon subgroup (FIP and BIP at 40 pmol each, Loop F and Loop B at 20 pmol each, F3 and B3 at 5 pmol each); (iii) Furthermore, all RIME-LAMP positive samples were tested for T. b. rhodesiense targeting the SRA gene (FIP and BIP at 40 pmol each, Loop F and Loop B at 20 pmol each, F3 and

B3 at 5 pmol each). RIME-LAMP positive and SRA-LAMP negative samples were considered to be Trypanosoma brucei brucei. The reaction mixture was incubated at 640C for 30 minutes in a heat block (Dry Thermounit DTU 1B, TAIEC Co., Saitama, Japan) and then at 950C for 2 minutes to terminate the reaction. The LAMP products were visualized using a transilluminator (WD, H19, Good design award Co., Japan).

Data analysis

Data was stored in basic excel format for easy handling and storage. The data was transferred to Stata / SE 8.0 (©1994 – 2003. Stata Corporation) for statistical analyses. Independent sample t-test was used to determine the association between continuous variables, while fisher's exact test was used to determine the association between categorical variables. P values < 0.05 were considered statistically significant.

Results

As shown in figure 2, the LAMP positive samples had bright green fluorescence colour when visualized under the transilluminator and could clearly be distinguished from the negative ones. The LAMP method revealed an overall trypanosome infection rate of cattle from the Choma-Kalomo agricultural block of 12.8% (95% CI: 9.7 –15.8%), with infections being mainly caused by T. congolense 9.5% (95% CI: 2.0 – 17.0%) while 2.4% (95% CI: -1.5 – 6.3%) of the animals were infected with T. b. brucei. In addition, 0.9% (95% CI: -1.5 – 13.3%) animals had mixed-infections of T. congolense and T. b. brucei. No T. b. rhodesiense was detected. When the disease prevalence was considered in individual crush pen (sampling sites), it was observed that only 6 out of the 13 crush pens recorded positive cases of bovine trypanosomiasis as follows: Nakalombwe 53.5% (95% CI: 39.0 – 68.4%), Kakuse 51.2% (95% CI: 36.3 – 66.1%), Mbila A 36.0% (95% CI: 17.2 – 54.9%), Fwentele 14.3% (95% CI: -11.6 – 40.2 %), Bungashiya 7.1% (95% CI: -2.4 – 16.6 %) and Maila Male 4.9% (95% CI: -1.7 – 11.5 %) (Fig. 3).

Discussion

Trypanosomiasis is a tsetse transmitted disease affecting both man and livestock in sub-Saharan Africa. This disease has serious socio-economic implications such that it remains a major obstacle to overall development in the affected regions (Hursey and Slingenberg, 1995). Because of the absence of an effective vaccine against the disease due to antigenic variation, trypanosomiasis control is achieved by either targeting the parasite or tsetse vector (Namangala, 2012). An attempt to eradicate tsetse flies in the Choma-Kalomo agricultural block was achieved through aerial spraying in 1987, which in turn resulted in improved animal and crop productivity (Connor,

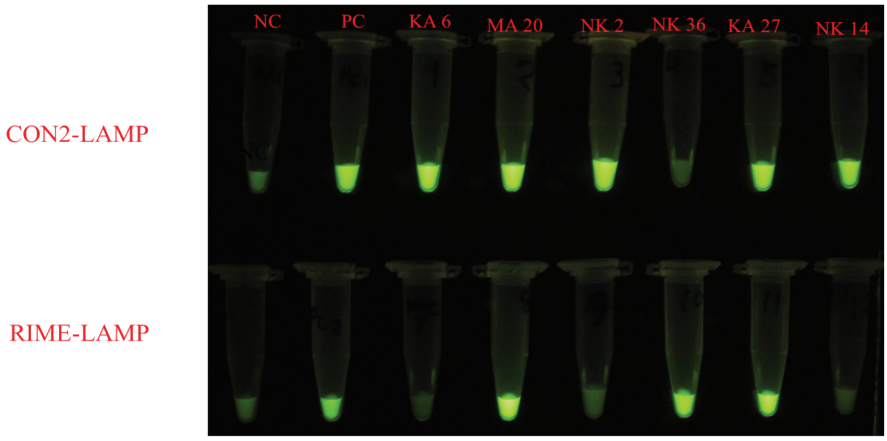


Figure 2: *Visual appearance of representative results for Trypanosoma congolense specific (CON2)-LAMP (upper row) targeting 18S rRNA gene and the repetitive insertion mobile element (RIME)-LAMP (lower row) specific for Trypanozoon subgroup. Loopamp® Fluorescent detection reagent was added to the reaction mixture at the beginning of the assay. The reactions were incubated at 64oC for 30 minutes. Positive samples exhibit a bright fluorescent green colour when visualized under the transilluminator. NC: Negative control (distilled water); PC: Positive control (T. congolense for CON2-LAMP; Trypanosoma brucei brucei for RIME-LAMP); KA: Kakuse; NK: Nakalombwe; MA: Mbila A; numbers 2, 6, 14, 20, 36, 27 signify sample identity.*

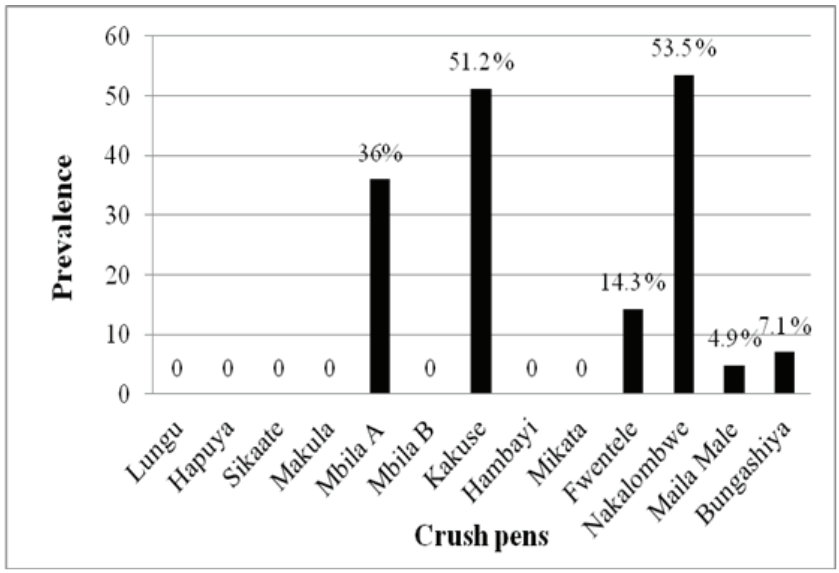


Figure 3: Determination of the distribution of trypanosome infected cattle across crush pens. The prevalence of trypanosomiasis in specific sampling sites within the Choma-Kalomo agricultural block was determined by LAMP tests specific for T. congolense, Trypanosoma brucei brucei and Trypanosoma brucei rhodesiense.

1989). In the present study, an attempt was made to investigate the prevalence of bovine trypanosomiasis in the previously aerial sprayed Choma-Kalomo agricultural block by means of a trypanosome-specific LAMP test. We report a 12.8% overall prevalence of trypanosomiasis, suggesting a resurgence of the disease in the Choma-Kalomo agricultural block. Moreover, the presence of tsetse flies in the Choma-Kalomo block was observed during the sampling exercise (unpublished observation).

The prevalence of bovine trypanosomiasis differed substantially between sampling sites within the Choma-Kalomo agricultural block. More importantly, trypanosome infections were generally only detected in sampling sites that were within close proximity to the Kafue National Park. To that effect, the highest prevalence of bovine trypanosomiasis recorded by LAMP was at Nakalombwe (53.5%) and Kakuse (51.2%), respectively, which were closest to the Kafue National Park. As the distance from Kafue National Park increases (see Fig. 1), the prevalence of the disease tended to decrease (36% in Mbila A; 14.3% in Fwentele; 7.1% in Bungashiya; 4.9% in Maila Male). In sampling sites that were much further away from the park, no infections were recorded. Considering that trypanosomes are tsetse-transmitted parasites, this observation may not be surprising as the tsetse density is expected to be higher within and in close proximity to the Kafue National Park which also harbour large populations of wildlife reservoirs (Symeonakis et al., 2007). According to Van den Bossche and Vale (2000), tsetse flies are more abundant in areas where livestock occupy the edge of tsetse-infested wildlife zones such as the Kafue National park. Our study revealed that the majority of the recorded trypanosome infections in cattle in the Choma-Kalomo agricultural block were caused by T. congolense. This is in conformity with previous reports in which T. congolense was documented to be the most common trypanosome species affecting cattle in southern Africa (Van den Bossche and Vale, 2000; Simukoko et al., 2010). Furthermore, Simukoko et al. (2007) reported that T. congolense accounted for about 34% of bovine trypanosomiasis in Eastern province of Zambia. Trypanosoma congolense and T. vivax are highly virulent parasites that cause debilitation, loss of productivity and death in cattle and other domestic livestock (Moloo et al., 2008). To that effect, most of the T. congolense infected cattle in the present study were debilitated and anaemic. On the other hand, T. b. brucei and T. b. rhodesiense are thought to be low pathogenic to domestic livestock such as cattle (Ochan, 2004; Njiru et al., 2004).

In conclusion, our data confirms the re-surgence of trypanosomiasis in the previously aerial sprayed Choma-Kalomo agricultural block. This was achieved through the use of trypanosome species-specific LAMP. Considering that LAMP is a highly sensitive and specific technique and yet user friendly (simpler, cheaper, quicker and that LAMP products may be visualized by

naked eyes), this test may in future prove to be instrumental in the routine accurate detection of such infections as trypanosomiasis in field samples in resource-limited countries such as Zambia. Future studies should investigate the prevalence of pathogenic trypanosomes in tsetse flies caught within the Choma-Kalomo block so as to give an indication of the risk of contracting the disease in the area.

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PRELIMINARY DIAGNOSIS ON THE GOATS TRYPANOSOMA VIVAX CHEMORESISTANCE TO ACETURATE DIMINAZENE AND ISOMETAMIDIUM CHLORIDE IN THE SAVANAH REGION IN TOGO

DIAGNOSTIC PRÉLIMINAIRE SUR LES CHÈVRES DE LA CHIMIORÉSISTANCE DE TRYPANOSOMA VIVAX À L'ACÉTURATE DE DIMINAZÈNE ET AU CHLORURE D'ISOMÉTAMIDIUM DANS LA RÉGION DES SAVANES AU TOGO

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Abstract

Trypanocidal drug resistance was suspected in the Savannas Region at the north of Togo. In order to verify this, laboratory experience was carried out on four stocks of Trypanosoma vivax collected in this region. Three hundred bovine blood samples was collected into 6 villages of breeding and examined by the buffy coat technique. By village, only positive samples with T. vivax were infested to one sahelian goat by intravenous inoculation in order to make stabilats. Each stabilat was reactivated on one goat which parasitic blood was infected to four goats of the same batch. By batch, the intramuscular alternative curative treatments with diminazene and isométamidium were successively applied. The average prevalence of trypanosomoses recorded was 6.66 %. The infestations were unique, T. vivax (75 % of) and mixed, T. vivax and with T. congolense (25 %).

Relapse rate, was 25 % with the amount 3.5 mg/kg bw of diminazene and 71.42 % with the amount 0.5 mg/kg bw of isometamidium. No case of relapse to 7 mg/kg bw of diminazene was not recorded, showing that the recommended

curative amounts (i.e. 3.5 mg/kg bw of diminazene and 0.5 mg/kg bw of isometamidium) seem ineffective with certain populations of T. vivax in the Savannas Area of Togo.

Key words: Drug resistance, Trypanosoma vivax, sahelian goat, Togo.

Résumé

La chimiorésistance des trypanosomes pathogènes du bétail a été suspectée dans la Région des Savanes, au Nord du Togo. Pour vérifier ce phénomène, une étude expérimentale de laboratoire à été réalisée sur quatre isolats de Trypanosoma vivax (T.vivax) collectés dans cette Région. Elle a consisté en l'analyse microscopique par la technique du buffy coat, des échantillons sanguins de 300 bovins de 6 villages d'élevage.Par village, les échantillons uniquement positifs à T. vivax ont été inoculés par voie intraveineuse à une chèvre afin de confectionner des cryostabilats. Chaque cryostabilat a été réactivé sur une chèvre dont le sang hyperparasitémique a été infesté à 2 groupes de chèvres d'un même lot. Par lot, les traitements curatifs alternatifs à l'acéturate de diminazène (AD) et au chlorure d'isométamidium (IMM) par voie intramusculaire ont été successivement appliqués. Une prévalence moyenne aux trypanosomoses de 6,66 % a été enregistrée. Il a été descellé des infestations uniques à T. vivax (75 %) et des infestations mixtes à T. vivax et à Trypanosoma congolense (25 %). Des taux de rechutes de 25 % à la dose 3,5 mg/kg de p.v. d'AD et de 71,42 % à la dose 0,5 mg/kg de p.v. d'IMM ont été enregistrés. Aucun cas de rechute à 7 mg/kg de p.v. d'AD n'a été enregistré, montrant que les doses curatives recommandées (3,5 mg/kg de p.v. d'AD et 0,5 mg/kg de p.v. d'IMM) semblent inefficaces vis-à vis de certaines populations de T. vivax de la Région des Savanes du Togo.

Mots clés : chimiorésistance, Trypanosoma vivax, chèvre sahelienne, Togo.

Introduction

Les trypanosomoses animales constituent encore un problème à la fois de santé et de développement agricole en Afrique subsaharienne (Mulumba, et al., 2005). L'agent causal, le trypanosome, est un hémoparasite transmis surtout par la mouche tsé-tsé (ou glossine). Depuis quelques décennies, plusieurs acteurs dont ceux du PATTEC, se sont impliqués dans la lutte contre le parasite et les vecteurs.

Au Togo, la lutte contre les trypanosomoses est menée à travers le contrôle des vecteurs, l'élevage sélectif des races d'animaux et très souvent l'utilisation

des trypanocides contre les trypanosomes. L'avènement de ces trypanocides a suscité beaucoup d'espoirs dans la lutte contre les trypanosomoses. Cependant, de plus en plus, l'on émet des doutes sur l'efficacité de ces molécules. Certaines seraient devenues inefficaces à cause d'une mauvaise utilisation ou à l'utilisation conjointe des homologues non assermentées. Tout compte fait, on assiste à l'émergence des souches résistantes. L'arsenal thérapeutique se réduit. L'acéturate de diminazène et le chlorure d'isométamidium sont les seuls molécules anciennes disponibles sur le marché. En revanche, des cas de résistance à ces molécules ont été démontrés (Diall, 2006 ; Geerts et Holmes, 1998). À nos jours, cette chimiorésistance a été déjà rapportée dans plus de 21 pays de l'Afrique Subsaharienne y compris le Togo (Talaki et al., 2013 ; Vitouley et al., 2011 ; Delespeaux et al., 2008). La première phase du projet IMT-CIRDES a montré que les infections à Trypanosoma vivax sont plus fréquentes au Nord du Togo. Elle a permis aussi d'identifier les villages suspects de chimiorésistance. Par contre, les données antérieures ne permettent pas de vérifier cette résistance. C'est pourquoi cette présente étude de caractérisation des isolats vis-à-vis des doses curatives de trypanocides recommandées pour le traitement de la trypanosomose a été engagée.

Elle a pour objectif de contribuer à l'amélioration des stratégies et outils d'épidémiosurveillance de la résistance par la collecte des données sur le parasite, Trypanosoma vivax.

Matériel et méthodes

Cadre de l'étude

L'enquête parasitologique de terrain a été menée dans la Région des Savanes au Nord-Togo (Figure 1). Les travaux de laboratoire se sont déroulés au laboratoire de Biologie moléculaire du CIRDES à Bobo-Dioulasso, Burkina Faso.

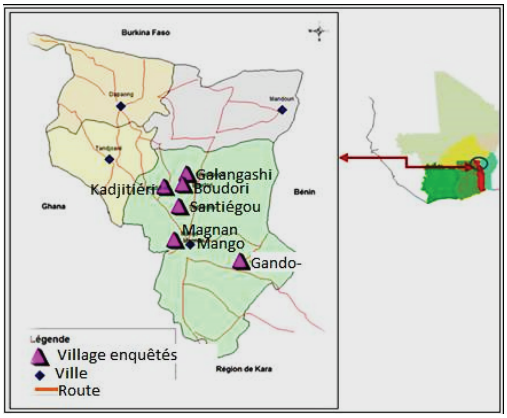


Figure 1 : *Village enquêtés pour la collecte des isolats de trypanosome*

Matériel animal

La collecte des données sur le terrain a concerné trois-cents (300) bovins de race Zébu et Borgou. Nous avons utilisé vingt-cinq (25) chèvres sahéliennes, femelles non gestantes, âgées de 9 à 20 mois. Cinq ont servi à la culture des trypanosomes sur le terrain et vingt pour les tests de chimiorésistance au laboratoire.

Enquête transversale sur le parasite

Le choix des villages d'élevage a été basé sur les résultats des études précédentes (Dao et al., 2008). Les critères ont été : un taux de prévalence minimum de 10%, l'acceptabilité des éleveurs, l'accessibilité des villages et la distance entre villages qui doit être d'au moins 6 km.

Le choix des bovins a été fait selon un mode aléatoire simple. Un échantillon aléatoire de 50 bovins par village re, soit 300 bovins dans six villages, a été fait.

Pour chaque bovin, un prélèvement sanguin a été réalisé au niveau de la veine jugulaire avec les tubes l'EDTA (Acide Ethylène-Diamine-Tétra-acétique) comme anticoagulant. L'évaluation du taux d'hématocrite et la recherche des trypanosomes ont été faites selon la technique du « Buffy Coat » (Murray et al., 1977). La concentration parasitaire (parasitémie) a été évaluée selon la méthode Paris et al. (1982). La détermination des espèces de trypanosomes a été faite en se basant sur la taille, la forme et la motilité telle que préconisée par l'OIE (OIE, 2000).

Stockage et culture in vivo des trypanosomes sur le terrain

Les chèvres (cinq chèvres) destinées au stockage et la culture des parasites sur le terrain ont été contrôlées puis blanchies à l'acéturate de diminazène à la dose de 7mg par kg poids vif. Elles ont aussi reçu également un déparasitage interne contre les parasitoses gastro-intestinales. Trois semaines après, ont été infestées par le sang des bovins révélés uniquement positifs à T. vivax à l'examen microscopique et provenant d'un seul et unique village. Ainsi, chaque chèvre a reçu une dose de 1ml de sang enrichi de deux Buffy Coat. Un contrôle quotidien (hématocrite, parasitémie) a été observé à partir du 5è jour après infestation jusqu'à l'obtention d'une concentration maximale de parasite. Ainsi, la confection des stabilats, par chèvre, cinq volumes de sang ont été prélevés puis dilué au Glycérol à 10 % (1ml de sang + 111µl de Glycérol). La conservation a été faite dans l'azote liquide.

Seuls quatre stocks identifiés comme suit : (i) T4C9R2-Magnan pour Magnan, (ii) T4C9R4-Santiégou pour Santiégou, (iii) T4C9R5-Boudori pour Boudori et (iv) T4C9R8-Gando-bongali ont été réalisés.

Caractérisation expérimentale de la chimiorésistance

Les chèvres destinées aux tests ont été réparties en quatre lots de cinq chèvres identifiées par des boucles. Par stock de trypanosome et par lot, une chèvre a été utilisée pour l'activation et la culture des parasites par inoculation à la veine jugulaire de 1ml d'inoculum. Un suivi quotidien a été fait à partir du troisième jour post-inoculation. Au premier pic de parasites constaté cher cette dernière, l'inoculation est faite par voie intraveineuse, uniquement aux chèvres du même lot. Pour se faire, le prélèvement est diluée au Phosphate Saline Glucosée (PSG) afin d'obtenir un inoculum de 105 trypanosomes par unité de volume.

Les traitements trypanocides au pic parasitaire ont été appliqués selon le canevas résumé dans le tableau 1. Les animaux traités ont été suivi régulièrement pendant 100 jours, conformément au protocole standard défini par Eisler et al. (2001) (Tableau 2).

Tableau 1 : *Canevas de traitement du troupeau expérimental*

Lot	**Sous-lot**	**Numéro d'identification**	**1er traitement**	**2ème traitement (1er rechute)**	**3ème traitement (2è rechute)**
4 chèvres	2 chèvres	1ot … D1 1ot … D2	3,5mg/kg p.v.	IMM : 0,5mg/kg p.v.	AD : 7mg/kg p.v.
	2 chèvres	1ot … I1 1ot … I2	0,5mg/kg p.v.	AD : 3,5mg/kg p.v.	AD : 7mg/kg p.v.

IMM : isométamidium, AD : diminazène, D1 : lot 1 traité à l'AD, D2 : lot 2 traité à l'AD, I1 : lot 1 traité à IMM, I2 : lot 2 traité à IMM, p.v : poids vif.

Tableau 2: *Canevas de suivi des paramètres biologiques et cliniques*

Paramètres	**Rythme du suivi**		**Durée minimale du suivi poste traitement**
	Avant traitement	**Après traitements**	
Signes cliniques	Quotidien	Quotidien	56 jours, à partir de la date de chaque traitement
Hématocrite	Quotidien	Chaque 2 jour	
Parasitémie	Quotidien	Chaque 2 jour	
Poids	Hebdomadaire	Hebdomadaire	
Autre (comportement)	Quotidien	Quotidien	

Analyse des données

La résistance de T. vivax à une dose de trypanocide a été admise pour l'ensemble de la zone d'étude lorsqu'au moins vingt pour cent (20 %) des chèvres traitées à une dose de 3,5 mg/kg de p.v. d'AD ou 0,5 mg/kg de p.v. d'IMM ont présenté des rechutes. Cette généralisation a été faite pour l'ensemble de la préfecture de l'Oti à cause de la proximité des villages de provenance des isolats de T. vivax.

Par ailleurs, lorsque dans un lot au moins une chèvre sur deux présente des rechutes après administration d'une dose donnée, l'isolat de T. vivax utilisé est déclaré résistant à la dose utilisée à cet effet. Au cas où aucune des deux chèvres traitées n'a présenté de rechutes, l'isolat est déclaré sensible. Ainsi, la sensibilité ou la résistance d'un isolat à une dose d'un trypanocide a été interprétée comme preuve de l'existence de deux types d'individus (individus résistants et individus sensibles) au sein des populations de T. vivax de la zone.

Résultats

Espèces de trypanosomes et prévalence

Deux espèces de trypanosomes pathogènes ont été diagnostiquées à savoir T. vivax et T. congolense. L'espèce T. vivax a été la plus fréquente.

Au total, vingt cas d'infestation trypanosomienne ont été enregistrés sur les 300 têtes de bovins suivis ; soit une prévalence parasitologique moyenne de 6,6%. L'étude a noté 15 (75 %) cas d'infestations uniques à T. vivax dans les 6 villages et cinq (25%) cas d'infestations mixte à T. vivax et T. congolense (Tableau 3). Aucune infestation unique à T. congolense n'a été enregistrée. Les plus fortes prévalences ont été enregistrées à Boudori (10%), à Magnan (10%) et à Gando-Bongali (8%) ; la plus faible prévalence a été enregistrée à Kadjitcheri (2%) (Tableau 3). Le village de N'Gongopri et celui de Santiégou ont présenté respectivement des prévalences de 6,0%, et 4,0%.

Le taux d'hématocrite moyen enregistré a été de 27,7 ± 0,3%. Le plus fort taux d'hématocrite a été enregistré à Boudori (31,7 ± 1,3%) tandis que le plus faible taux d'hématocrite a été enregistré à Magnan (26 ± 1,5%). Dans les autres localités, l'hématocrite a été de : (i) 26,3 ± 1,2% à Gando-Bongali, (ii) 26,6 ± 1,27% à Kadjitiéri, (iii) 27,1 ± 1,3% à Santigou et (iv) 28,7 ± 1,2% au Ranch-Namiélé. L'hématocrite moyen enregistré chez les bovins détectés positifs a été 27,7 ± 2,4 % contre 27,8 ± 0,5 % chez les animaux négatifs.

Tableau 3 : *Prévalence trypanosomienne par village enquêté*

Villages	Taille de l'échantillon	Positifs	Prévalence
Magnan	50	5	10%
Kadjitiéri	50	1	2%
Santiégou	50	2	4%
Boudori	50	5	10%
N'Gongopri	50	3	6%
Gando-Bongali	50	4	8%
Effectif	300	20	6,6

Résultats de la caractérisation expérimentale des isolats

L'évolution de la parasitémie et de l'hématocrite chez les chèvres ayant servi au stockage des isolats sur le terrain est présentée dans le tableau 4.

Chez les chèvres d'amplification, à l'exception d'une chèvre ayant reçu un isolat issu de Gando-Bongali, toutes les chèvres expérimentales (16) ont réagi positivement à l'infestation en ce sens qu'elles ont manifesté des symptômes de trypanosomose et ont été détectées positives à l'analyse parasitologique. Les symptômes se sont traduits par un état de dépression générale, des larmoiements et un amaigrissement dans 56,2% (9 chèvres sur 16). Ces symptômes ont été persistants dans 43,7% des cas (7 chèvres sur 16). Les signes ont été plus prononcés chez des animaux qui ont fait des rechutes.

Les périodes de prépatence post-infestation (PPI) ont été plus longues que les périodes de prépatence post-traitement (PPT) (Tableau 5). En effet, les périodes PPI ont varié entre 4 et 7 jours, soit en moyenne 5,1 ± 0,1 jours. Après le 1er traitement elles ont varié entre 14 et 16 jours, soit en moyenne 14,8 ± 1 jours. Au stade du 2è traitement, ces périodes ont varié entre 17 et 23 jours, soit en moyenne, 20 ± 3,4 jours (Tableau 5).

Tableau 4 : *Parasitémie et hématocrite des chèvres de stockage des isolats sur le terrain*

Dates	Paramètres	Chèvre 1	Chèvre 2	Chèvre 3	Chèvre 4	Chèvre 5
T0	Poids	10,25	8,3	9,5	10	8,8
(inoculation-PP)	Hématocrite	27	28	37	28	31
	PP (jours)	5	4	4	4	4
09/10/2011	Hématocrite	18	-	-	-	-
	Parasitémie	75/1	-	-	-	-
10/10/2011	Hématocrite	18	20	26	21	25
	Trypano	75/50	02/50	1/50	1/50	-
11/10/2011	Hématocrite	16	22	25	20	26
	Parasitémie	5/1	8/50	7/50	1/50	-
12/10/2011	Hématocrite	14	22	24	21	26
	Parasitémie	1/1	3/50	5/50	0	2/50
13/10/2011	Hématocrite	14	24	27	23	24
	Parasitémie	2/1	2/1	50/1**	0	10/50
14/10/2011	Hématocrite	14	24	26	23	23
	Trypano	4/1	0/50	6/1	0	3/1
15/10/2011	Hématocrite	16	23	24	28	24
	Parasitémie	50/1**	6/40	6/1	0/50	10/1**
16/10/2011	Hématocrite	-	-	-	-	-
	Parasitémie	-	-	-	-	-
17/10/2011	Hématocrite	14	19	23	25	24
	Parasitémie	8/1	8/1**	0/50	0/50	40/1
18/10/2011	Hématocrite				25	21
	Parasitémie				05/50	5/1
19/10/2011	Hématocrite				1/1	21
	Parasitémie				24	2/50
20/10/2011	Hématocrite				17	25
	Parasitémie				40/1	2/50

*** : Confection de stabilats ; parasitémie : nombre de trypanosomes par champ microscopique ; PP : période prépatente*

Tableau 5 : *Récapitulatif de l'évolution de la parasitémie des lots expérimentaux*

Isolats	**Lots**	**PP**	**1er traitement**	**PP**	**2è traitement**	**PP**	**3è traitement**
Magnan	$1D_1$	6	AD,		Pas de rechutes		
	$1D_2$	6	3,5 mg/kg p.v.				
	$1I_1$	6	IMM	16	AD		
	$1I_2$	7	0.5 mg/kg p.v.	16	3,5 mg/kg de p.v.		
Santiégou	$2D_1$	5	AD,		Pas de rechutes		
	$2D_2$	5	3,5 mg/kg p.v.				
	$2\,I_1$	5	IMM	16	AD	23	AD
	$2\,I_2$	5	0.5 mg/kg p.v.	14	3,5 mg/kg de p.v.		7mg/kg de p.v.
Boudori	$3D_1$	4	AD		Pas de rechutes		
	$3D_2$	5	3,5 mg/kg p.v				
	$3I_1$	4	IMM				
	$3I_2$	4	0.5 mg/kg p.v.				
Gando-Bongali	$4D_1$	5	AD,	13	IMM	17	AD
	$4D_2$	5	3,5 mg/kg p.v.	13	0.5 mg/kg de p.v.	20	7 mg/kg de p.v.
	$4I_1$	5	isométamidium,	16	diminazène, 3,5		Pas de rechutes
			0.5 mg/kg p.v.		mg/kg de p.v.		
	$4I_2$		Négative après infection				

IMM: isométamidium, AD: diminazène, D1: lot 1 traité à l'AD, D2: lot 2 traité à l'AD, I1: lot 1 traité à IMM, I2: lot 2 traité à IMM, p.v: poids vif.

Discussions

Les résultats montrent une hétérogénéité dans la répartition spatiale de la trypanosomose dans la zone car la prévalence a varié entre 10% et 2%, soit une moyenne de 6%. En revanche à Mô, dans la zone subhumide du sud de l'Atakora au Togo, Talaki et al. (2014) ont enregistré une prévalence comprise entre 32,56 et 43,59% pour une moyenne de 37,64 %. Les values enregistrées dans la présente étude peuvent être établies si nous considérons l'éffet saison. En effet, pendant la saison pluvieuse, les glossines ont une activité maximale et une large distribution dans la savane d'où une baisse des possibilités de contact avec l'hôte et donc une diminution du risque d'infestation du bétail par les trypanosomes (Dao et al., (2008; Djiteye et al., 1997 ; Itard, 1981). Par ailleurs, dans les villages où les traitements récents se sont avérés, la faible prévalence peut être en partie attribuée aux isolats chimiorésistants. Toutefois, seul un suivi longitudinale sur le terrain peu permettre de mieux élucider la situation épidémiologique dans la zone. Selon les types d'infestation trypanosomiennes, la forte prévalence de T. vivax trouvée est contraire à celle établie antérieurement par Hendrickx et Napala (1999). Ces auteurs ont trouvé que T. congolense est l'espèce la plus fréquente dans cette région. La situation actuelle peut s'expliquer par l'action des facteurs anthropiques. Celles-ci auraient entrainé une régression de Glossina morsitans qui transmet plus facilement T. congolense.

En ce qui concerne les délais de résurgence des parasites, la présente étude a montré que, ces délais ont été relativement longs par rapport à ceux observés après infestation. Mamman et al. (1995) soulignent à cet effet que, les souches de trypanosomes résistantes ont une certaine tendance à accroitre moins vite que les souches sensibles. L'effet curatif des molécules aurait contribué au maintien de l'évolution de la population des parasites à un seuil minimal. Ceci, en dépit de l'élimination des individus sensibles et/ou de l'inhibition temporaire des certaines fonctions vitales des parasites. L'utilisation de la PCR devrait permettre de mieux relativiser cet écart. Qu'elle soit précoce ou tardive, la résurgence des parasites après une administration efficace d'une dose curative de molécule laisse prévoir une chimiorésistance selon les critères établis (Eisler et al,. 2001). Il est important de souligner que, la recherche des parasites a été faite par la technique classique du BCT. Cette technique, est reconnue être sensible pour un diagnostic de terrain et permet d'identifier de façon rapide les animaux dont la parasitémie est de l'ordre de 300 à 700 trypanosomes par ml (Murry et al., 1977). Cependant, l'utilisation des techniques plus sensibles comme la technique par PCR ou la technique ELISA pourrait permettre de recueillir des données beaucoup plus proches de la réalité.

L'analyse des proportions de rechutes montre une forte tendance à la résistance à l'isométamidium. Des résultats similaires (c'est-à-dire des taux de rechutes

élevés à l'isométamidium) ont été trouvés avec les isolats de T. congolense dans la plupart des sites de chimiorésistance en Afrique Subsaharienne (Clausen et al., 1992 ; Peregrine et al., 1990). La même tendance a été observée par Diarra (2001) avec les isolats récoltés dans la province du Kénédougou au Burkina Faso, par la méthode standard de test sur les souris. Par contre, Fairclough (1963) a soutenu qu'il était difficile que la dose 0,5 mg/kg de pv. d'IMM induise une résistance chez T. vivax. Dans cette étude toutefois, hétérogénéité de la sensibilité des isolats vis-à-vis de cette dose peut s'expliquer par la présence d'au moins deux populations de T. vivax, les unes résistantes et les autres sensibles. Très peu sont les études qui évoquent la résistance de T. vivax au diminazène. Dans cette étude, une résistance à 3,5 mg/kg de p. c. de diminazène a été mise en évidence au sein des populations de parasites de l'isolat Gando-Bongali. La forte proportion des cas de sensibilité à cette dose, corrobore les conclusions de Peregrine et Maman (1993) et celles de Chitambo et Arkwal (1991) en ce qui concerne l'efficacité du diminazène contre les trypanosomes du bétail. Cependant que des rechutes ont été observées à la dose 7mg/kg de diminazène (Desalegn et al. 2010 ; Codjia et al. 1993), aucun cas de résistance à cette dose n'a été observé dans cette étude.

La résistance croisée à l'isométamidium et au diminazène est rarement observée dans les traitements des trypanosomes du bétail (Anene et al., 2000 ; Ainanshe et al., 1992) ; c'est pourquoi ces deux molécules sont souvent utilisées alternativement pour combattre les souches résistantes de trypanosomes ; c'est le traitement «sanatif» (Whitside, 1960). Toutefois, des cas de résistance croisées ont été démontrés dans les conditions expérimentales de terrain et de laboratoire (Talaki, 2008 ; Peregrine et al., 1997 ; Peregrine, 1994 ; Clausen et al., 1992) et ont été diversement interprétés selon les auteurs. Les résultats obtenus avec l'isolat Gando-Bongali laissent penser à l'existence des individus double résistants. Il semble difficile à ce stade expérimental de se prononcer avec certitude sur l'existence ou non d'une résistance croisée aux deux molécules utilisées. Les échecs au traitement «sanatif» mis en évidence peuvent être dus à la présence au sein des isolats, des individus résistants à l'une ou à l'autre des doses curatives utilisées tel qu'il a été démontré dans les études de Buridi et al. (1992).

Conclusion

Cette étude sur le diagnostic biologique de la chimiorésistance des trypanosomes aux trypanocides est la première du genre à être conduite au Togo. Les résultats révèlent l'émergence probable des premiers foyers de chimiorésistance au Togo. Des études supplémentaires basées sur les outils moléculaires ont été proposées afin de mieux cerner le phénomène.

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UNE ÉTUDE (BASÉE SUR LA PCR) DES TRYPANOSOMES ANIMAUX AFRICAINS ET DES PARASITES DE PIROPLASMES SÉLECTIONNÉS CHEZ LES BOVINS ET LES OVINS EN ZAMBIE

A PCR BASED SURVEY OF ANIMAL AFRICAN TRYPANOSOMES AND SELECTED PIROPLASM PARASITES OF CATTLE AND GOATS IN ZAMBIA.

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Résumé

Nous avons examiné des bovins et des ovins en Zambie dans le but de détecter la présence de trypanosomes animaux africains, Babesia bigemina et Theileria parva dans les districts de Chama, Monze et Mumbwa, en utilisant des tests PCR. 38,1% des échantillons ont été positifs pour au moins une des espèces parasites. Le parasite le plus fréquent était Trypanosoma vivax (19,8%), dont le taux était significativement plus élevé chez les chèvres que chez les bovins ($p < 0,05$). L'espèce B. bigemina a été trouvée dans les trois zones, ce qui en fait le parasite le plus répandu.

Parmi les échantillons positifs, 12,0% étaient des infections mixtes. Il y avait des différences significatives entre les taux d'infection de T.vivax, Mumbwa ayant un taux d'infection significativement plus élevé de 39,6% ($p < 0,0001$) Th. Parva, Monze ayant les seuls cas ($p < 0,0004$) et B.bigemina, Monze ayant

un taux d'infection significativement plus élevé 40,5% (p <0,0001). Selon les valeurs d'hématocrite, on a noté que les PCV des bovins avec infections mixtes étaient significativement inférieurs par rapport aux autres. La présence de multiples espèces de parasites et d'infections mixtes chez les bovins et les ovins a une importance à la fois clinique et économique pour l'élevage. L'absence de trypanosomose dans les échantillons prélevés à Monze peut être attribuée à l'éradication de la mouche tsé-tsé autour du lac Kariba. Ceci montre que la prévention et le contrôle des vecteurs peuvent produire une différence significative dans le statut de la maladie, qui peut directement se traduire par l'amélioration du secteur de l'élevage en Zambie.

Abstract

We screened cattle and goats in Zambia for the presence of animal African trypanosomes, Babesia bigemina and Theileria parva from the districts of Chama, Monze and Mumbwa using PCR assays. 38.1% of the samples tested positive for at least one of the parasite species.

The commonest parasite was Trypanosoma vivax (19.8%) which was significantly higher in goats than cattle, ($p<0.05$).B. bigemina was found in all the three areas making it the most wide spread of the parasites. Among the positive samples 12.0% were mixed infections. There were significant differences in T.vivax infection rates with Mumbwa having a significantly higher infection rate 39.6%($p<0.0001$), Th. parva with Monze having the only cases ($p<0.0004$)and B.bigemina with Monze having a significantly higher infection rate 40.5%($p<0.0001$). According to the hematocrit values, there was significantly lower PCV among cattle with mixed infections compared to the others. The presence of multiple parasite species and mixed infections among the cattle and goat populations is of both clinical and economic importance to livestock farming. The absence of trypanosomosis among the samples collected from Monze can be attributed to tsetse eradication around Lake Kariba. This shows prevention and control of vectors can cause a significant difference in the disease status which can directly translate to improvement of the livestock sector in Zambia.

Hemoprotozoan parasites, which include different species of Theileria, Babesia and Trypanosoma, often present a challenge to successful livestock farming [25]. Theileria and Babesia species are among the major piroplasms that affect cattle and small ruminants [7]. Tick-borne diseases cause significant economic losses in the tropical and sub-tropical regions of the world [1, 11]. Among the Babesia species, Babesia bovis and B. bigemina are clinically and economically important; both species are widely distributed in tropical and sub-tropical countries [4]. Theileria annulata and Th. parva, the two most lymphoproliferative Theileria parasites, are considered to be

the most pathogenic to cattle [18]. Th. parva is prevalent in Eastern, Central and Southern Africa [31]. Animal African trypanosomosis (AAT) affects all domestic animals and a wide range of wildlife species, which act as an infection reservoir for both humans and domestic animals [2]. In cattle, the disease is caused by T. vivax, T. congolense and T. brucei brucei [14]. These trypanosomes are transmitted cyclically by the tsetse fly (Diptera: Glossinidae).

The mode of transmission of T. vivax is distinct in that it can also be transmitted mechanically by biting flies, such as tabanids. This has resulted in the occurrence of AAT due to T. vivax outside the tsetse belts of Africa [6, 12]. Bovine trypanosomosis is a threat to livestock health and agricultural production and thereby affects rural development and poverty alleviation efforts in Africa [29].

Amongst the five Theileria species and subspecies that areknown to exist in Zambia, the most economically important are Th. parva parva and Th. parva lawrencei [15]. B. bovis and B. bigemina are recognized as being of economic importance to the Zambian cattle sector [15]. B. bigemina is shown to be widespread in Zambia, whereas B. bovis is mostly restricted to the eastern and north-eastern parts of the country [10]. Infections caused by B. bigemina are more extensive than those caused by B. bovis, and this may be attributed to the wider vector range of B. bigemina [15].

In Zambia, trypanosomosis has more of an endemic na- ture and is characterized by high morbidity and rather low mortality. However, the devastating effects of trypanosomosis on livestock production are very obvious in areas where susceptible livestock are introduced in a tsetse-infested zone or vice versa. A good example is the plateau of eastern Zambia where devastating livestock trypanosomosis epidemics occurred after game and tsetse spread south and east from the Luangwa valley onto the plateau [29]. The reason for the epidemic nature of trypanosomosis is attributed to the diversity in trypanosome populations [16]. As a result of drug use and the high mortality rates in untreated animals infected with virulent strains, the likelihood that virulent strains will persist in the livestock that are susceptible to the domestic transmission cycle is low. On the low plateau of eastern Zambia, for example, only 20% of the trypanosome strains isolated from cattle had a virulent phenotype [17].

Moreover, laboratory experiments indicated that the presence of an infection with a low-virulence trypanosome strain confers protection against the deleterious effects of infection with a virulent strain [16]. This study aims to assess the prevalence of trypanosomes and selected piroplasms that are

of great importance to livestock farming in the areas of Chama, Monze and Mumbwa in Zambia. The present study will generate information that will provide a glimpse of the nature of the behavior and diseases associated with these parasites among the cattle and goats in these areas.

MATERIALS AND METHODS

The study area and sample size: Sample collection was conducted in Chama (Muchinga province), Mumbwa (Central province) and Monze (Southern province) districts during the dry season (May to October) of 2010 (Fig. 1). A total of 472 heads of cattle from Chama (n=292), Mumbwa (n=96) and Monze (n=84) and 53 goats (all from Chama) were examined for the presence of animal African trypanosomes (Trypanozoon, T. congolense and T. vivax), B. bigemina and Th. parva using PCRs.

Sample collection and DNA preparation: Blood samples were collected from cattle and goats whose owners gave their consent to participate in the survey. Permission was obtained according to the standards of animal experimentation in Obihiro University of Agriculture and Veterinary Medicine (Approval No. 28–47), and Department of Veterinary and Livestock Development, Zambia (Approval No. 212CO100011192). Approximately 5 ml of blood was drawn from the jugular vein of each animal using vacutainer tubes with EDTA-2Na (Terumo Co., Tokyo, Japan) and loaded into capillary tubes, and the packed cell volume (PCV) values were determined. These procedures were conducted in the field at the sampling site. In addition, the total DNA of each blood sample (1 ml) was isolated using a DNA isolation kit for mammalian blood (Roche Diagnostics, Mannheim, Germany) according to the manufacturer's suggested protocol. The isolated DNA was stored at −30°C until use.

The detection of hemoparasites by PCR: This study used 2 different PCR techniques to detect and identify trypanosomes:

(i) a KIN-PCR, which amplifies internal transcribed spacer 1 (ITS1), was used for Trypanozoon (T. brucei brucei, T. b. rhodesiense, T. b. gambiense, T. evansi and T. equiperdum) and T. congolense; and (ii) a TviCatL-PCR, which amplifies the highly conserved Cathepsin L-like gene among T. vivax isolates [5, 19]. A PCR that amplifies apical membrane antigen-1 (AMA-1) was used for B. bigemina, while a p104 gene PCR, which uses IL755 and IL3231 primers to amplify the p104 gene, was used for Th. parva (Table 1) [24, 26]. All of the parasites were detected using single-step PCR methods; for the trypanosomes, the PCR reactions included 1 µl of 10 × reaction buffer, 0.3 µl 50 mM magnesium chloride, 250 µM dNTPs and 0.1 µl of Taq DNA polymerase (all from Thermo Fisher Scientific Inc., Waltham, MA, U.S.A.), 1 µl of each of the forward and reverse primers and 5.1 µl of double-distilled

water; 0.5 µl of the DNA sample was added to the individual PCR mixtures. The PCRs were conducted using a VeritiTM Thermal cycler (Thermo Fisher Scientific). The PCR conditions have been described previously [13]. For the piroplasms, the PCR reactions included 1 µl of 10 × reaction buffer, 200 µM dNTPs and 0.1 µl of Taq DNA polymerase (AmpliTaq gold®) (all from Thermo Fisher Scientific), 0.5 µl each of the forward and reverse primers and 5.9 µl of double-distilled water. One microliter of the DNA sample was added to the individual PCR mixtures. The PCRs were conducted using a VeritiTM thermal cycler. The PCR conditions that were used for the Babesia and Theileria species have been described previously [24, 26].

Statistical analysis: The 95% confidence intervals were determined using the Creative Research Systems software program (accessed at www.surveysystems.com). The chisquared and Fisher's exact tests were performed, the significance of their associations was tested, and p-values were determined using the GraphPad Prism software program (GraphPad Software Inc., La Jolla, CA, U.S.A.). Associations between the hematocrit values and the various parasitic infections were analyzed using a one-way analysis of variance, the strengths of the associations were tested using Tukey's mean difference, and P-values were determined using the GraphPad Prism software program.

RESULTS

Parasite prevalence by species: In the present study, 200 of the 525 (38.1%) samples were found to be positive for at least one hemoprotozoan parasite. T. congolense, Trypanozoon, T. vivax, B. bigemina and Th. parva were identified in cattle and goat samples collected from the three study locations (Table 2). T. vivax, which was detected in 19.8% of the samples, was the most common parasite. The prevalence of T. vivax in goats (37.7%) was significantly higher than that in cattle (17.8%) (Table 3). The second most common parasite was B. bigemina, which was present in 16.1% of cattle. This was followed by T. congolense (1.9% and 5.7% in cattle and goats, respectively), then Trypanozoon (1.0%in cattle only) and lastly Th. parva (0.6% in cattle only). T. vivax was the only parasite that had a significant difference in the infection rate between cattle and goats (Table 3). Twelve percent of the infected samples were mixed infections (Table 4). The most frequent mixed infections were T. vivax/B. bigemina (7.0%), followed by T. congolense/T. vivax (2.5%), then T. congolense/B. bigemina (1.0%) and B. bigemina/Th. Parva (1.0%) and lastly T. congolense/T. vivax/B. bigemina (0.6% in cattle) (Table 4).

The prevalence rates according to location: No trypanosome- positive samples were found in the samples from Monze, and all the Th. parva positive samples were from Monze. The area with the highest cattle infection rate was Mumbwa (69.8%) followed by Monze (44.0%) and Chama (25.0%) (Table 2). Although

there were no significant differences in the Trypanozoon and T. congolense infection rates, there were significant differences in the rates of T. vivax, Th. parva and B. bigemina positivity, with Mumbwa having a significantly higher prevalence of T. vivax (39.6%), and Monze having the only Th. parva positive samples and a significantly higher prevalence of B. bigemina (40.5%) (Table 2). Chama was the only area in which goat samples were collected; in the other study areas, only cattle samples were collected. B. bigemina was the only parasite found across all three areas, with the highest prevalence in Monze (40.5%) followed by Mumbwa (24.0%) and Chama (6.5%) (Table 2). In Chama and Mumbwa, T. vivax was the most prevalent trypanosome in cattle (15.8% and 39.6%, respectively) followed by T. congolense (1.4% and 5.2%) and finally Trypanozoon (1.4% and 1.0%) (Table 2).

Prevalence according to age and sex: There were no significant differences in the infection rates according to age or sex in the cattle and goats; however, male cattle (39.5%) had a higher rate of infection than female cattle (36.3%). In contrast, female goats (62.5%) had a higher rate of infection than male goats (38.5%). Adult animals (cattle, >2 years of age; and goats, >0.5 years of age) of both species had a higher incidence than juvenile animals (42.1 vs. 26.8% in cattle and 58.1 vs. 54.5% in goats).

The relationship between PCV and infection: According to the hematocrit values, there was no significant difference between the positive and negative samples from goats (data not shown). In cattle, however, there were significant differences between the mixed infections, the single infections infected and non-infected goats did not differ to a statistically significant extent. This could be because they are more tolerant to these parasites than cattle and because trypanosomosis in goats commonly follows a subclinical path—usually with low but persistent parasitemia [3, 8, 22, 23].

Our results showed that goats can be an important reservoir for trypanosomes and that the treatment of goats could lead to a reduction in the incidence of Trypanosomosis in Zambia and other African countries.

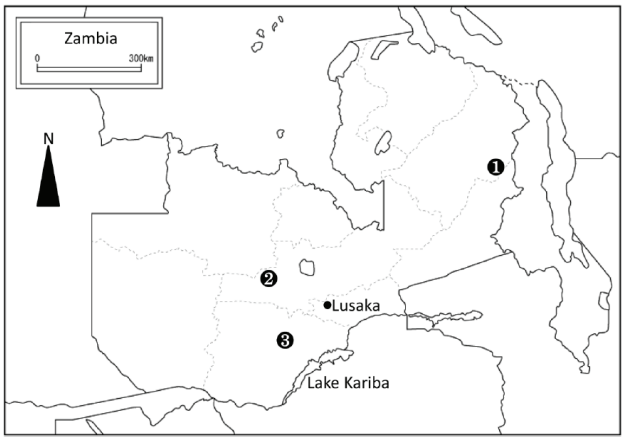


Fig. 1. A map of Zambia showing the sampled areas. The numbers on the map indicate the locations of Chama (❶), Mumbwa (❷) and Monze (❸). A free map of Zambia was obtained from http://www.freemap.jp.

Table 1. The PCR primer sets

Target gene	Primer	Sequence (5′→3′)	Specificity	Size (bp)	Reference
ITS1	KIN1	GCGTTCAAAGATTGGGCAAT	*T. congolense*	750[a)]	McLaughlin *et al.*, 1996
	KIN2	CGCCCGAAAGTTCACC	*Trypanozoon*	540[a)]	
CatL-like*	TviCatL1	GCCATCGCCAAGTACCTCGCCGA	*T. vivax*	177	Cortez *et al.*, 2009
	DTO 155	TTAAAGCTTCCACGAGTTCTTGATGATCCAGTA			
AMA-1	BI-AMA-F1	TACTGTGACGAGGACGGATC	*B. bigemina*	211	Sivakumar *et al.*, 2012a
	BI-AMA-R1	CCTCAAAAGCAGATTCGAGT			
P104	IL3231	ATTTAAGGAACCTGACGTGACTGC	*Th. parva*	496	Skilton *et al.*, 2002
	IL755	TAAGATGCCGACTATTAATGACACC			

**Trypanosoma vivax* cathepsin L-like cysteine protease. a) The KIN1 and KIN2 oligonucleotides are specific for both *T. congolense* (750 bp) and *Trypanozoon* (540 bp).

Table 2. The parasite infection rates at the three study locations

Location	Host	N	P	%	*Trypanozoon*		*T. congolense*		*T. vivax*		*B. bigemina*		*Th. parva*	
					P	%	P	%	P	%	P	%	P	%
Chama	Cattle	292	73	25.0	4	1.4	4	1.4	46	15.8	19	6.5	0	0
	Goats	53	23	43.4	0	0	3	5.7	20	37.7	0	0	0	0
Monze	Cattle	84	37	44.0	0	0	0	0	0	0	34	40.5	3	3.6
Mumbwa	Cattle	96	67	69.8	1	1.0	5	5.2	38	39.6	23	24.0	0	0
Total		525	200	38.1	5	1.0	12	2.3	104	19.8	76	14.5	3	0.6
P value					0.615		0.057		<0.0001*, a)		<0.0001*, b)		0.0004*, c)	

*Statistically significant ($P<0.05$). a) The *T. vivax* infection rate in Mumbwa was significantly higher than that at other locations. b) The *B. bigemina* infection rate in Monze was significantly higher than that at other locations. c) *Th. parva* was only found in Monze. N, number of samples; P, number of PCR-positive samples.

Table 3. The infection rates for each species and parasite

Species	N	P	%	*Trypanozoon*		*T. congolense*		*T. vivax*		*B. bigemina*		*Th. parva*	
				P	%	P	%	P	%	P	%	P	%
Cattle	472	177	37.5	5	1.1	9	1.9	84	17.8	76	16.1	3	0.6
Goats	53	23	43.4	0	0	3	5.7	20	37.7	0	0	0	0
Total	525	200	38.1	5	1.0	12	2.3	104	19.8	76	14.5	3	0.6
P value				ND		0.111		0.025*, a)		ND		ND	

*Statistically significant ($P<0.05$). a) The *T. vivax* infection rate was significantly higher in goats than in cattle. ND, not done; N, number of samples; P, number of PCR-positive samples.

Table 4. Mixed infections according to the species

Species	TP	MI	%	Tc/Tv		Tc/Bb		Tv/Bb		Bb/Tp		Tc/Tv/Bb	
				P	%	P	%	P	%	P	%	P	%
Cattle	177	22	12.4	3	1.7	2	1.1	14	7.9	2	1.1	1	0.6
Goats	23	2	8.7	2	8.7	0	0	0	0	0	0	0	0
Total	200	24	12.0	5	2.5	2	1.0	14	7.0	2	1.0	1	0.5

Tc/Tv, Tc/Bb, Tv/Bb, Bb/Tp and Tc/Tv/Bb indicate a mixed infection with the corresponding parasites. TP, total number of PCR-positive samples; MI, number of mixed infection-positive samples; P, number of PCR-positive samples for each parasite. Tc, *T. congolense*; Tv, *T. vivax*; Bb, *B. bigemina*; Tp, *Th. parva*.

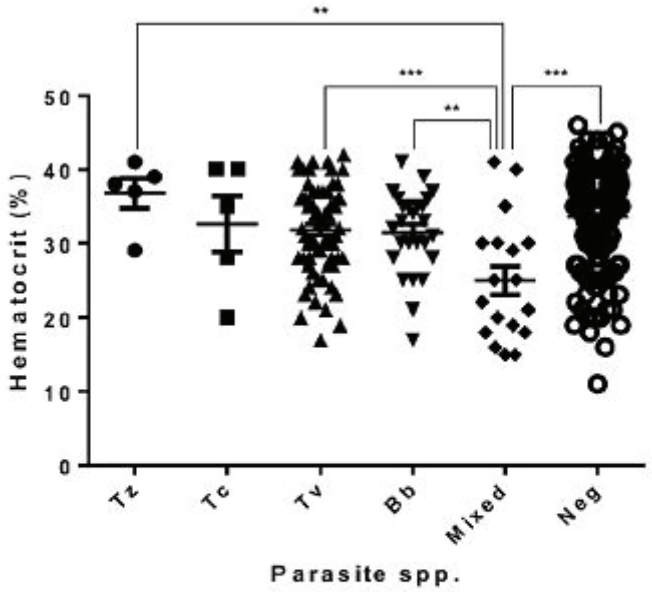


Fig. 2. A graph comparing the PCV values of cattle with various parasite infections. A comparison of the hematocrit values in cattle with mixed-infection, various parasitic infections and uninfected cattle. The bars and asterisks denote the levels of significance (**$P<0.05$, ***$P<0.0001$). Tz,*Trypanozoon;* Tc,*T. congolense*; Tv,*T. vivax*; Bb, *B. bigemina*; Mixed, mixed infections; Neg, negative for the screened parasites.

In conclusion, we revealed that the prevalence of hemoprotozoan parasites was high in the cattle and goats in Zambia.

This result suggests that the control of these parasites and vectors is important for the improvement of the agriculturalsector in Zambia.

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L'EFFICACITÉ DE LA SULPHADIMIDINE, DE LA GENTAMICINE, DE 'OXYTÉTRACYCLINE ET LEURS ASSOCIATIONS CHEZ DES CHÈVRES NUBIENNES INFECTÉES EXPÉRIMENTALEMENT AVEC TRYPANOSOMA EVANSI

THE EFFICACY OF SULPHADIMIDINE, GENTAMICIN, OXYTETRACYCLINE AND THEIR COMBINATIONS IN NUBIAN GOATS EXPRIMENTALLY INFECTED WITH TRYPANOSOMA EVANSI

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Résumé

L'objectif de l'étude était d'évaluer l'efficacité de la sulphadimidine, de la gentamicine, de l'oxytétracycline et de leurs combinaisons chez les chèvres nubiennes infectées expérimentalement par T.evansi. Huit groupes ont été utilisés dans cette étude. Tous les groupes expérimentaux ont été infectés avec T.evansi à l'exception du groupe (1) non infecté et non traité. Alors que le groupe (2) a été infecté et non traité, les groupes (3, 4 et 5) ont été traités respectivement avec une dose unique d'i / m de sulfamadine (200 mg / kg), de gentamicine (4 mg / kg) et d'oxytétracycline (20 mg / kg). Les groupes (6, 7 et 8) ont chacunété traités avec une dose unique d'i / m de l'association sulfamadine (200 mg / kg) + gentamicine (4 mg / kg) ; de sulphadimidine (200 mg / kg) + oxytétracycline (20 mg / kg) ; et de gentamicine (4 mg / kg) + Oxytétracycline (20 mg / kg). Aucun signe clinique n'a été détecté chez les chèvres des groupes (3#8) après le traitement. Aucun changement significatif n'a été observé en ce qui concerne la température, le taux respiratoire, le pouls et la fréquence cardiaque chez les groupes (2 # 8) et pour le nombre de globules rouges, l'hématocrite, le taux d'hémoglobine et les indices érythrocytaires et la numération leucocytaire, les taux d'éosinophiles, de basophiles et de protéines totales sériques par rapport au Groupe témoin 1. Des diminutions significatives ont été enregistrées dans les taux de glucose et d'albumine sérique, tandis que des augmentations significatives des taux de neutrophiles, de monocytes, de lymphocytes, de globulines, d'azote uréique et dans l'activité GOT chez la plupart des groupes traités.

Les doses de sulfadimidine, d'oxytétracycline et de leurs associations ont permis d'éliminer les parasites du sang périphérique depuis la semaine 4 après le traitement jusqu'à la fin de l'expérience, tandis qu'une dose unique d'i/m de gentamicine et ses associations avec la sulphadimidine et l'oxytétracycline ont éliminé les parasites du sang périphérique respectivement aux semaines 8 et 9 après le traitement.

Sur base des résultats enregistrés, on conclut que les médicaments testés et leurs associations ont été efficaces contre les trypanosomes. L'étude a recommandé la possibilité de traiter la trypanosomiase avec de la sulphadimidine, de la gentamicine, de l'oxytétracycline et leurs associations.

Mots-clés : Trypanosoma evansi, efficacité, sulphadimidine, gentamicine, oxytétracycline.

Abstract

The objective of the present study was to evaluate the efficacy of sulphadimidine, gentamicin, oxytetracycline and their combinations in Nubian goats experimentally infected with T.evansi. Eight groups were used in this study. All experimental groups were infected with T.evansi except group (1) uninfected and untreated. While group (2) was infected and untreated, groups (3, 4, and 5) were treated with single i/m dose of sulphadimidine (200mg/kg), gentamicin (4mg/kg) and oxytetracycline (20mg/kg) respectively. Groups (6, 7 and 8) were each treated with single i/m dose of combination of sulphadimidine (200mg/kg) + gentamicin (4mg/kg), sulphadimidine (200mg/kg) + oxytetracycline (20mg/kg) and gentamicin (4mg/kg) + oxytetracycline (20mg/kg) respectively. No clinical signs were shown on goats of groups (3#8) post treatment. No significant changes were observed for the temperature, respiratory rate, pulse rate and heart rate in groups (2#8) and for the RBCs count, PCV, haemoglobin concentration and the red blood cells indices and WBCs count, eosinophils, basophils and serum total proteins concentrations compared to the control group 1. Significant decreases were recorded in glucose and albumin serum concentration, while significant increases in the neutrophils, monocytes, lymphocytes, globulins, urea serum concentration and in the activity of GOT in most treated groups. Doses of sulphadimidine, oxytetracycline and their combinations cleared the peripheral blood from the parasite since week 4 post treatment to the end of the experiment, while single i/m of gentamicin and its combinations with sulphadimidine and oxytetracycline cleared the parasitaemia of the peripheral blood at week 8 and 9 post treatment respectively.

The present results concluded that, the drugs tested and their combinations had trypanocidal efficacy. The study recommended the possibility of treatment of trypanosomiasis with sulphadimidine, gentamicin, oxytetracycline and their combinations.

Keywords: Trypanosoma evansi, Efficacy, Sulphadimidine, Gentamicin, Oxytetracycline.

Introduction

In Republic of South Sudan, goats are reared for milk, meat and socially in marriage and play a very important role in the rural economy. It is well known that trypan-osomosis is a vector-born disease of humans and livestock. It is caused by a unicellular, flagellated protozoa of the genus trypanos-oma, and it is a major health problem for domestic and wild life animals particularly in Africa, Asia and South America.

Trypanosomosis in goats produces acute, subacute, chronic or subclinical forms. The most causative trypanosomes for goats are T.evansi, T.vivax, and T. conglense. Generally four groups of anti-trypanosome are used: Diamidines compounds, Aminoph-enanthridium compounds, Quinapyramine compounds and other compounds such as Melarsorpol, Cymelarsan (Arsenical compounds), Suramine, Samorine and Nitrovin-ylferan (Bywater, et al., 1991). It is important to realize that drugs alone will not treat the disease because trypanosomosis overwhelms the immune system. Treatment will be more effective in well fed and rested animals as chemotherapy stopping the multiplication of trypanosomes and this helps the immune system to overcome the infection (Osman, et al., 1992). The control of trypanosomosis depends on two ways: the use of chemotherapy/chemoprophylaxis programs and vector control. However, the treatment/prophylactic programs is the current method going on because it is easier to eradicate the trypanosomes than the vectors. The appearance of trypanosomes drug-resistant makes also the use of the available drugs a problem facing the veterinarians in the field for treatment of trypanosomosis. In addition, almost no new drugs have been developed for more than 30 years and some have been withdrawn from the market either the manufacturer stopped as in case of Quinapyramine or withdrawn due to its ineffectivity due to resistant. Thus, those remaining in use require careful management in order to minimize resistance problem (Brown, et al., 1990).

In Sudan, field veterinarians use antibiotics such as Sulphadimidine, Gentamicin and Oxytetracycline in combination with the available trypanocide for the treatment of trypanosomiasis. These antibiotics are used in order to control the secondary bacterial invasion due to the suppressed immune status.

But its observed that in many instances when the trypanocidal drugs are not available specially in nomads herds, how treated the animals with the above mentioned antibiotics in order to overcome the secondary infection and the animal relies on its immune system. There was a believe that, these antibiotics had a trypanocidal effect, because the animals were improved and their blood was free of the parasites when were examined. For these reasons the present experiment was conducted to investigate the efficacy of Sulphadimidine, Gentamicin, Oxytetracycline and their combinations in Nubian goats experimentally infected with T.evansi.

Materials and Methods

Experimental Design

Twenty four (24) Nubian goats of both sexes aged 1-3 years and weighing 13-20 kg were purchased from local markets. All animals were housed in a Fly-proof barn at the College of Veterinary Medicine, Sudan University of Science and Technology. They were supplied with limited concentrates and minerals twice a day and grass fodder Sorghum vulagarae, with free access water. Animals were allowed to acclimatize for one month before the commencement of the experiment during which animals were carefully examined for blood parasites, internal and external parasites. Animals were divided randomly into 8 groups each consisted of three goats. Control negative (group 1) was uninfected and untreated. The remaining experimental groups (2-8) were all inoculated intravenously with 1ml blood containing 5 x 10¬ parasites T.evansi stock Gad tryp (1) as count using modified scoring method (Ismail, 1988). The parasites were activated by adding phosphate buffered saline with glucose (PSG) before inoculation. Control positive (group 2) was infected and untreated. Animals in groups 3, 4, and 5 were each given single i/m dose of sulphadimidine (200mg/kg), gentamicin (4mg/kg) and oxytetracycline (20mg/kg) respectively.While animals in Groups 6, 7 and 8 were each given single i/m dose of combination of sulphadimidine (200mg/kg) + gentamicin (4mg/kg), sulphadimidine (200mg/kg) + oxytetracycline (20mg/kg) and gentamicin (4mg/kg) + oxytetracycline (20mg/kg) respectively. The treatment started immediately after the appearance of parasite in peripheral blood. The duration of the experiment was 9 weeks.

Techniques used for blood collection Blood was collected daily for parasitaemia investigation, while the blood was collected every three days for haematological and biochemical investigations throughout the duration of the experimental period. Blood was collected through jugular vein puncture using 5ml disposable syringe. 2ml of collected blood was harvested into vacuota-iners containing ethylene diamine tetraacetic acid (EDTA) for parasitological and haematological investigations. Parasitol-ogical investigations were

determined using the methods of wet blood film, buffy cout technique (Murray et al., 1977) and haemocytometer technique (Ismail, 1988). The haematological investigations determi-ned by measurement of Hb concentr-ation using commercial kits (Muslcosj-Saudi Arabia for Laboratory Limited), RBCs count, PCV, MCV, MCH, MCHC, WBCs count and differential white blood cells count (Schalm et al., 2000). The remaining 3ml of blood was used for serum analysis.

Samples were collected into plain vacuotainers left for 3-4 hours at room temperature then separated by using a centrifuge with 3000 rounds/minute and the clear serum was harvested and kept at -20 ! until analysed for the measurement of glucose, total proteins and albumin using commercial kits (Fortress Diagnostics Limited, United Kingdom), while globulins were measured by subtracting the albumin from total proteins concentration. GOT serum activity and urea concentration were measured using commercial kits (Medical Device Safety Services, Germany).

Clinical parameters

All experimental animals were inspected several times a day for physical changes and clinical signs. Rectal temperature, respiratory rate, pulse rate and heart rate were recorded every three days for duration of 9 weeks.

Statistical analysis

All data were computerized using MSTAT- C program (Michgan State University), for the analysis of variance and for mean separation (version 10).

Results

Clinical signs

All goats of group 2 (control positive) showed lack of appetite, weight loss, emaciation, recumbency and death on week 3 post-infection. No clinical signs and mortality were recorded for groups 3, 4, 5, 6, 7 and 8 post-treatment till the end of the experiment (week 9). The clinical parameters in Nubian goats experimentally infected with T.evansi and treated with sulphadimidine, gentamicin, oxytetracycline and their combinations are shown in table

(1). No significant changes were observed for the rectal temperature, respiratory rate, pulse rate and heart rate in the infected and the infected-treated goats compared to the control group1.

Haematological parameters

The haematological parameters in Nubian goats experimentally infected with T.evansi and treated with sulphadimidine, gentamicin and oxytetracycline and their combinations are shown in table (2). There were no significant changes recorded for the RBCs count, PCV, haemoglobin concen-tration and the red blood cells indices. But, decreases in the RBCs count, PCV, haemoglobin concentration and the MCH were noticed in most treated groups. The white blood cells and the differential white blood cells count in Nubian goats experimentally infected with T.evansi and treated with sulphadimidine, gentamicin, oxytetracycline and their combinations are shown in table (3). There were no significant changes observed in the tested groups for the WBC counts, basophils and eosinophils, while significant increases were observed for the neutrophils in groups (3-7), lymphocytes (4- 8) and the monocytes (groups 2-8) compared to the control group 1.

Serobiochemical parameters

The biochemical parameters in Nubian goats experimentally infected with T.evansi and treated with sulphadimidine, gentamicin, oxytetracycline and their combinations are shown in table (4). Significant decreases were recorded in glucose and albumin serum concentration in groups (2-8) while significant increases in the globulins in groups (2-8) and urea serum concentration in groups (2- 6 and 8) and in the serum activity of GOT in groups (2, 4, 6 and 8).

The efficacy of sulphadimidine, gentamicin, oxytetracycline and their combinations.

The efficacy of sulphadimidine, gentam-icin, oxytetracycline and their combinations in Nubian goats experimentally infected with T.evansi is shown in table (5) and figures (1-6). Results showed that single i/m dose of sulphadimidine, oxytetracycline and their combinations cleared the parasite from the peripheral blood at week 4 to the end of the experiments, while single i/m dose of gentamicin and its combinations with sulphadimidine and oxytetracycline cleared the parasitaemia of the peripheral blood at week 8 and 9 respectively, during this period no clinical signs.

Discussion

The objectives of the present study were to investigate the efficacies of Sulphadimidine, Gentamicin, Oxytetracycline and their combinations in Nubian goats experiment-ally infected with T.evansi.

Sheep and goats are extensively used as model laboratory animals for various pathological and pharmacological studies of T.evansi (Dargantes et al., 2005, Youssif, 2005). In this study the parasitaemia in all infected groups started to appear in week 1 and reached the maximum on week 2, and on weeks 3 post infection. Youssif et al. (2008) studied the efficacy and toxicity of Cymerlarsan in Nubian goats experimentally infected with T. evansi and found that the parasite was detected in the peripheral blood of goats was mild on days 4-5 and moderate on day 6 and severe on days 7-10 until the animal died on days 9-11 post infection. Dargie et al. (1979); Murray and Dexter, (1988), mentioned that peaks of the parasitaemic waves are usually high within this acute period. Death may occur at any phase of the disease or the animal may recover naturally (Uzoigwe, 1986).

Drug resistance emerged as a real problem facing the treatment of animal trypano-somiasis (Elrayah et al., 1999) and this forcing towards the need for newer drugs to be used as trypanocidal agents. Katzung (2007) mentioned the use of antibiotics in treatments of protozoans, for example tetracycline and doxycycline are active against malaria and toxoplasmosis.

Sulphonamides are used for the treatment of protozoal diseases for example Riviere and Papich,(2009) mentioned that treatment of coccidiosis in birds and animals. This may be the first trail to use a folate inhibitor in treatment of trypanosomiasis.

In the present study when sulphadimidine was given at single i/m dose animals survived and the peripheral blood was cleared from the parasite since week 4 to the end of the experiment. Stephen et al. (2007) mentioned that folic acid is an important co-factor in all living cells, and bacteria and protozoa are unable to take up exogenous folate and must synthesize it themselves. This is carried out in a series of reactions involving first the synthesis of dihydr-opteroic acid from one molecule each of pteridine, P-aminobenzoic acid (PABA) and sulphonamides are structural analogues of PABA competitively inhibit the incorpo-ration of PABA into dihydropteroic acid and inhibit subsequent metabolism.

The efficacy of gentamicin at single i/m dose cleared the peripheral blood of the parasite since week 8 till the end of the experiment. This might be the first time to use gentamicin for treatment of trypano-somes.

Katzung (2007) mentioned that the mecha-nism of aminoglycosides are irreversible inhibitors of protein synthesis, and inside the cell, aminoglycosides

bind to specific 30S-subunit ribosomal proteins and the protein synthesis is inhibited.

The efficacy of oxytetracycline at single i/m dose succeeded to eliminate the parasite from the peripheral blood at week 4 and all the animals were survived until the end of the experiment. Rang et al.(2009) mentioned that tetracyclines are bacteri-ostatic inhibitors of protein synthesis and accumulated intracellularly and binds bacterial ribosomal subunit (30S).

Masocha et al. (2006) mentioned that minocycline impedes African trypanosome invasion of the brain in a murine model that daily administration of minocycline impedes the penetration of leucocytes and trypanosomes into the brain parenchyma of T. brucei-brucei infected mice, and the loss of weight occurring during infection was not observed after treatment and those mice also survived longer than non-treated mice with minocycline. Minocycline and other tetracyclines antibiotics have been used in combination therapy against other parasitic diseases.

Although the mode of action of antibiotics in treatment of protozoan till now is not clearly understood, but we believe that it acts to a certain level as its mode of action on bacteria and other microorganisms.

The efficacy of the combination of single i/m dose of sulphadimidine and gentamicin combination eliminated the parasite on week 9 and the animals were survived till the end of the experiment, while the efficacy of the combination of single i/m dose of gentamycin and oxytetracycline eliminated the parasite from the peripheral blood on week 8 but the single i/m dose of sulphadimidine and oxytetracycline eliminate the parasite on week 4 and the animals were survived till the end of the experiment.

Riviere and Papich, (2009)described many drug combinations used in treatment of protozoal diseases, such as treatment of Sarcocystis neurona in horses (pyrem-ethamine + sulphadizine), Neuspora caninum in dogs (pyremmethamine + sulphadizine), Toxoplasma gondii in dogs and cats (pyremmethamine + sulphadizine), Eimeria sp and Isospora sp in dogs and cats (ormetoprim + sulphadizine) also (trimethoprim + sulphadiazine) and coccidiosis in cats also treated by combination of (Amprolium + sulphadimethoxine).

Bywater et al. (1991) mentioned in multi-drug therapy it sometimes happens that the response seen is less than the sum of the component responses, in

which case there has been antagonism between the drugs used. Antagonism can sometimes be explained on the basis of one drug interfering with or even reversing the action of the other. The use of a mixture which contains a bacteriostatic sulphonamide and bactericidal antibiotic exemplifies this possibility is that penicillin achieves its greatest antibacterial effect when the organism is multiplying rapidly. A sulphonamide arrest cell division and so reduces the usefulness of the antibiotic. Antibiotics are generally used alone, but may on occasion be prescribed in combinations. Combining two antibiotics may result in synergism, indifference or antagonism. In case of synergism, neutral inhibition is achieved at concentrations below that for each agent alone and may prove advantageous in treating relatively insusceptible infections (penicillin + gentamicin), another advantage is that it may enable the use of toxic agents where dose reduction is possible (amphotericin B + 5-flucylosine), another advantage is to prevent resistance emerging during treatment (fusidic + flucloxacillin), but the most common reason for using combined therapy is in treatment of confirmed or suspected mixed infection where a single agent alone will fail to cover all pathogenic organisms (metronidazole + aminoglycosides or a broad spectrum cephalo-sporins). Finally in cases who are seriously ill and about when uncertainty exists concerning the microbiological nature of the infection (Denyer et al., 2004).

No clinical signs were shown by the groups infected with T. evansi and treated with sulphadimidine, gentamicin, oxytetracycline and their combinations.

Clinical parameters in this study showed no significant changes recorded for the temperature, respiratory rate, pulse rate and heart rate in any of the experimental animals, although, there was slight increase in the temperature in some groups infected and treated. Body temperature varies according to the phases of the disease. Fiennes, (1970), Valera et al.(2005) and Akinwale et al. (2006) noticed that febrile changes in trypanosomosis could be demonstrated by plotting three-day average peak, with regular intervals each lasting for 2-3 days. A period following a temperature peak when trypanosomes were being destroyed in very large numbers is termed cold crisis (Fiennes, 1970). Youssif (2000) revealed that hyperthermia and hypothermia in goats infected with T.vivax is controversial. Youssif (2005) recorded the decrease in pulse rate and respiratory rate and increase in heart rate in T.vivax infected goats. While Anosa and Isoun, (1980) reported increase in respiratory rate in cattle infected with T.vivax.

There were no significant changes recorded in this study for the RBCs count, PCV, haemoglobin concentration and the red blood cells indices. But, decreases in the RBCs count and Hb concentration, PCV, MCH and the MCV were noticed specially in infected and treated groups compared to the control

group. This coincides with findings of Saror, (1980); Sekoni et al. (1990) and Silva et al. (1999) in T.vivax and T.congolense infections in cattle and Sharma et al.(2000) in T.evansi infection in Barbari goats. The decrease in PCV might be correlated with the decrease in total red blood cells count or due to haemodilution while the decrease in Hb concentration may be due to the decrease in PCV and RBCs count. The decrease in the above mentioned parameters indicates the state of anaemia in the infected groups (Sharma et al., 2000). This anaemia might be due to the haemolysis by proteases, phospholipases and nueramidases induced by trypanosomes (Soulsby, 1982). Trypanosomes may causedirect mechanical injury to erythrocytes and other cells by the lashing action of their powerful flagella and microtubule-reinforced bodies (Vickerman and Tetley, 1978).

In the present study there were no changes in the total white blood cells count, eosinophils and basophils, while an increases in the neutrophils, monocytes and lymphocytes were seen in some of the treated groups.Taylor and Authei, (2003) reported increase in phagocytosis of leukocytes, platelets in animals infected with T.congolense and T.vivax. Goosssens et al. (1998) also revealed increase in WBCs count in chronic phase in sheep infected with T.congolense. Total leukocyte counts may drop by 30 to 50% in trypanosomes infected animals; the initial decrease is due mainly to an absolute decrease in T-cell, eosinophils, lymphocytes and neutrophils (Wellde, 1983 and Anosa, 1988). In contrast, monocytes may have a transient increase. Macrophages, neutrophils and eosinophils are able to destroy opsonized trypanosomes and to remove circulating immune complexes (Taylor and Authei, 2003).

The serobiochemical parameters in this study showed significant decreases in serum glucose concentration in the tested groups compared to that of the control negative, this agree with Kadima et al.(2000) that reported hypoglycaemia may occurred at the periods of high parasitaemia or at the terminal stage in cattle with acute T.vivax infection but did not occur in chronically infected cattle. Decrease of serum glucose was noticed in sheep infected with T.congolense or T.brucei (Taiwo et al., 2007).

Significant increases were observed in serum urea concentration and GOT activity in the tested groups compared to that of the control negative, this agree with Steven and Micheal. (2002) mentioned that GOT is a common marker of hepatocytes damage, but muscle damage, haemolysis and other processes also increase serum GOT activity. Youssif (2005) reported the increase of GOT activity in Nubian goats infected with T.evansi. The increase of serum urea agree with (Cheesbrough, 1998). A decreasing GFR (Glomerular Filtration rate) is the best indicator of renal insufficiency, and since UN (urea nitrogen) and CT (creatinine) are both freely filtered by the glomerulus they are the

analysts most commonly used to estimate GFR. As the GFR decreases plasma UN and CT increase, however GFR must be reduced by 75% before UN and CT increase in blood plasma. Because azotemia is not evident until 75% of nephron are no longer functioning adequately, and because the ability to concentrate urine is best after 66% of nephons are compromised.

Thrall et al.(2012) mentioned that decreased serum UN implies decreased production of urea, either due to hepatic failure or post systemic shunt. The same author mentioned that dehydration, hypovolumia and shock are non renal factors that increase serum UN and CT, while gastrointestinal haemorrhage increase the UN only.

No significant changes were recorded for serum total proteins for all experimental groups. Tabel et al. (1980) recorded an increase of total proteins and albumin in sheep infected with T.congolense. Adeiza et al. (2008) recorded decrease of total proteins in sheep and goats infected with T.congolense, T.vivax and T.brucei. A decrease of albumin and elevation of globulins in sheep, goats and cattle infected with T.congolense and T.vivax was reported by Anosa and Isoun, (1976).

Thrall et al.(2012) mentioned that an increased concentration of serum albumin is seen only with dehydration. Decreased serum albumin is seen with glomerular diseases and is also seen with diseases in gastrointestinal, liver and cardiovascular system.

This study concluded that treatment of trypanosomiasis with sulphadimidine, gentamicin, oxytetracycline and their combinations were successful in elimination the parasite from the peripheral blood of the infected animals without any serious adverse effects on the vital organs, and the animals were survived for 9 weeks post infection. Also it is recommended to use of the above mentioned drugs and their combinations as new treatment strategies of trypanosomiasis. Further studies are needed to highlights on the mode of actions of these antibiotics on the trypanosome.

Table 1: Clinical parameters in Nubian goats infected with T.EVANSI and treated with sulphadimidine, gentamicin, oxytetracycline and their combinations (Mean±SE)

Groups/Parameters	Temperature ^{0}C	Respiratory rate (inspiration/min)	Pulse rate (thrills/min)	Heart rate (beats/min)
Group 1 uninfected and untreated (control negative)	38.3±0.26%	32.4±0.27%	80.2±0.44%	92.7±0.51%
Group 2 infected and untreated (control positive)	39.1±0.29%	34.4±0.26%	78.6±0.37%	87.5±0.47%
Group 3 infected and treated with sulphadimidine 200mg/kg b.w	38.9±0.27%	30.0±0.26%	83.1±0.47%	99.0±0.50%
Group 4 infected and treated with gentamicin 4mg/kg b.w	38.8±0.26%	35.7±0.22%	86.1±0.41%	102±0.53%
Group 5 infected and treated with oxytetracycline 20mg/kg b.w	38.8±0.28%	29.8±0.25%	83.5±0.49%	104±0.52%
Group 6 infected and treated with sulphadimidine +gentamicin (200mg/kg +4mg/kg) b. w	39.0±0.20%	26.3±0.19%	87.4±0.27%	106±0.72%
Group 7 infected and treated with sulphadimidine + oxytetracycline (200mg/kg +20mg/kg) b. w	38.8±0.28%	29.8±0.25%	83.5±0.49%	104±0.52%
Group 8 infected and treated with gentamicin +oxytetracycline (4mg/kg +20mg/kg) b. w	39.0±0.21%	33.9±0.24%	85.9±0.50%	102±0.53%

Table 2: Haematological parameters in Nubian goats infected with T.EVANSI and treated with sulphadimidine, gentamicin, oxytetracycline and their combinations (Mean±SE)

Groups/Parameters	RBCs (x10,/ mm/)	PCV (%)	Hemaglobin (g/dl)	MCV (Fl)	MCH (Pg)	MCHC (g/dl)
Group 1 uninfected and untreated (control negative)	7.39±0.03%	26.1±0.18%	9.42±0.04%	61.6±0.20%	55.4±0.03%	34.3±0.26%
Group 2 infected and untreated (control positive)	5.43±0.04%	21.1±0.16%	9.40±0.05%	59.0±0.18%	41.6±0.02%	44.7±0.23%
Group 3 infected and treated with sulphadimidine 200mg/kg b.w	4.96±0.02%	20.8±0.20%	6.82±0.03%	55.7±0.13%	29.8±0.01%	36.8±0.27%
Group 4 infected and treated with gentamicin 4mg/kg b.w	4.15±0.03%	19.9±0.14%	6.74±0.03%	58.9±0.17%	31.7±0.01%	40.4±0.23%
Group 5 infected and treated with oxytetracycline 20mg/kg b.w	4.84±0.02%	19.5±0.18%	7.35±0.03%	49.0±0.12%	19.2±0.01%	40.2±0.22%
Group 6 infected and treated with sulphadimidine +gentamicin (200mg/kg +4mg/kg) b. w	4.43±0.02%	20.9±0.15%	7.73±0.05%	65.6±0.28%	36.7±0.02%	41.1±0.27%
Group 7 infected and treated with sulphadimidine + oxytetracycline (200mg/kg +20mg/kg) b. w	4.84±0.02%	19.5±0.18%	7.35±0.03%	49.0±0.22%	19.2±0.01%	40.2±0.22%
Group 8 infected and treated with gentamicin +oxytetracycline (4mg/ kg +20mg/kg) b. w	4.00±0.02%	19.4±0.18%	7.19±0.02%	62.0±0.22%	24.2±0.01%	40.0±0.21%

Table 3: White blood cells count in Nubian goats infected with T.EVANSI and treated with sulphadimidine, gentamicin, oxytetracycline and their combinations (Mean±SE)

Groups/Parameters	WBCs (x10//11/)	Neutrophils (11/)	Lymphocytes (11/)	Monocytes (11/)	Basophils (11/)	Eosinophils (11/)
Group 1 uninfected and untreated (control negative)	6.40±0.05%	0.77±0.03%	5.45±0.02%	0.84±0.04%	0.05±0.00%	0.23±0.01%
Group 2 infected and untreated (control positive)	6.73±0.03%	0.52±0.02%	5.55±0.03%	1.84±0.022	0.09±0.00%	0.07±0.00%
Group 3 infected and treated with sulphadimidine 200mg/kg b.w	7.44±0.04%	1.55±0.042	7.89±0.06%	2.42±0.012	0.05±0.00%	0.31±0.01%
Group 4 infected and treated with gentamicin 4mg/kg b.w	6.65±0.03%	1.16±0.032	13.0±0.092	1.55±0.022	0±0.0%	0.29±0.01%
Group 5 infected and treated with oxytetracycline 20mg/kg b.w	7.95±0.04%	1.26±0.022	9.44±0.04%2	2.80±0.022	0.02±0.00%	0.59±0.02%
Group 6 infected and treated with sulphadimidine +gentamicin (200mg/kg +4mg/kg) b. w	7.14±0.04%	0.82±0.032	10.9±0.092	3.33±0.052	0.04±0.00%	0.27±0.01%
Group 7 infected and treated with sulphadimidine + oxytetracycline (200mg/kg +20mg/kg) b. w	7.95±0.04%	1.26±0.012	9.44±0.04%2	2.80±0.022	0.02±0.00%	0.59±0.02%
Group 8 infected and treated with gentamicin +oxytetracycline (4mg/kg +20mg/kg) b. w	6.39±0.04%	0.99±0.01%	10.5±0.07%2	1.33±0.012	0.07±0.00%	0.19±0.01%

(a,b,):Different letters in one column showed the significant at p≤0.05 difference

Table (4) Serobiochemical parameters in Nubian goats infected with T.EVANSI and treated with sulphadimidine, gentamicin, oxytetracycline and their combinations (Mean±SE)

Groups/Parameters	Glucose (g/dl)	Total proteins (g/dl)	Albumin (g/dl)	Globulin (g/dl)	Urea (mg/dl)	GOT (U/l)
Group 1 uninfected and untreated (control negative)	74.1±0.27%	8.50±0.05%	5.49±0.04%	3.01±0.012	55.9±0.24%	217±1.23%
Group 2 infected and untreated (control positive)	58.8±0.272	7.14±0.02%	3.62±0.022	3.52±0.022	88.4±0.222	251±1.292
Group 3 infected and treated with sulphadimidine 200mg/kg b.w	56.3±0.262	8.06±0.06%	3.71±0.022	4.98±0.022	71.8±0.262	213±1.21%
Group 4 infected and treated with gentamicin 4mg/kg b.w	55.4±0.222	7.58±0.04%	3.30±0.012	4.15±0.022	80.3±0.252	251±1.232
Group 5 infected and treated with oxytetracycline 20mg/kg b.w	50.6±0.202	7.68±0.05%	3.56±0.022	4.12±0.012	68.0±0.192	219±1.23%
Group 6 infected and treated with sulphadimidine +gentamicin (200mg/kg +4mg/kg) b. w	51.8±0.252	7.00±0.03%	3.23±0.022	3.77±0.012	73.1±0.222	239±1.272
Group 7 infected and treated with sulphadimidine + oxytetracycline (200mg/kg +20mg/kg) b. w	50.6±0.202	7.68±0.05%	3.56±0.022	4.12±0.012	68.0±0.19%	219±1.23%
Group 8 infected and treated with gentamicin +oxytetracycline (4mg/kg +20mg/kg) b. w	49.7±0.162	7.29±0.04%	3.06±0.012	4.23±0.022	70.4±0.202	242±1.292

(a,b,):Different letters in one column showed the significant at p≤0.05 difference

Table (5) Efficacy of sulphadimidine, gentamicin, oxytetracycline and theircombinations in Nubian goats experimentally infected withT. EVANSI (Mean±SE)

Groups/Weeks	1	2	3	4	5	6	7	8	9
Group 1 uninfected and untreated (control negative)	0±0.34	0±0.34	0±0.34	0±3 34	0±0.34	0±0.34	0±0.34	0±0.34	0±0.34
Group 2 infected and untreated (control positive)	0.5±0.3 5	0.93±0.3 5	0.28±0.364			Animals were died			
Group 3 infected and treated with sulphadimidine 200mg/ kg b.w	0.56±0.3 5	1.96±0.365	0.43±0.3 4	0±0.34	0±0.34	0±0.34	0±0.34	0±0.34	0±0.34
Group 4 infected and treated with gentamicin 4mg/kg b.w	0.1±0.34	0.96±0.3 5	0.57±0.364	0.86±0.3 5	0.28±0.365	0.28±0.365	0.28±0.365	0±0.34	0±0.34
Group 5 infected and treated with oxytetracycline 20mg/ kg b.w	0.54±0.3 5	0.94±0.3 5	0.43±0.3 4	0±0.34	0±0.34	0±0.34	0±0.34	0±0.34	0±0.34
Group 6 infected and treated with sulphadimidine +gentamicin (200mg/kg +4mg/ kg) b. w	0±0.34	0.97±0.365	1.76±0.378	0.61±0.395:	0.18±0.3 :	0.57±0.395	0.28±0.364	0.28±0.364	0±0.34
Group 7 infected and treated with sulphadimidine + oxytetracycline (200mg/kg +20mg/kg) b. w	0.54±0.3 5	0.94±0.3 5	0.43±0.3 4	0±0.34	0±0.34	0±0.34	0±0.34	0±0.34	0±0.34
Group 8 infected and treated with gentamicin +oxytetracycline (4mg/kg +20mg/kg) b. w	0.1±0.34	1.5±0.3 5	1.16±0.365	0.94±0.3 5	0.24±0.3 5	0.43±0.365	0.14±0.3 5	0±0.34	0±0.34

(a,b,):Different letters in one column showed the significant at p≤0.05 difference

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PÉRIODE DE PROTECTION PAR LE CHLORURE D'ISOMETAMÉDIUM (SAMORIN) CONTRE LA TRYPANOSOMOSE DANS LES ZONES AVEC DIVERSES DENSITES DE MOUCHES TSE-TSE DANS LE DISTRICT DE MAMBWE

PROTECTIVE PERIOD FOR ISOMETAMEDIUM CHLORIDE (SAMORIN) AGAINST TRYPANOSOMIASIS IN AREAS WITH VARYING TSETSE CHALLENGE IN MAMBWE DISTRICT

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Résumé

Contexte : La trypanosomiase animale africaine (TAA) causée par les mouches tsé-tsé est une contrainte majeure à la production animale dans les régions habitées de l'Afrique tropicale. La Zambie n'a pas été épargnée, car les éleveurs dans les zones affectées dépendent fortement de l'utilisation de médicaments pour traiter la maladie. Cependant, pour la prophylaxie, l'administration de médicaments doit se faire correctement, ce qui n'est pas le cas dans la plupart des localités éloignées.

Objectif : Déterminer l'efficacité du Samorin pour la prophylaxie chez les bovins dans les zones présentant différentes densités d'infestation demouches tsé-tsé.

Méthode : Trois zones ont été sélectionnées intentionnellement avec 3 niveaux d'infestation : Faible, Moyen et Élevé. Des suivis mensuels ont été effectués pendant six mois, et au cours de cette période, des échantillons de sang provenant de troupeaux sentinelles ont été analysés sur base d'un Buffy Coat quantitatif, de frottis épais et minces et de l'hématocrite.

Résultats : On n'a pas relevé de différence significative au niveau de la période d'efficacité du Samorin dans les 3 régions sélectionnées du district de Mambwe. Les animaux ont maintenu le niveau de protection du médicament prophylactique pendant la période de 6 mois.

Conclusion : Le samorin doit être administré une ou deux fois par an dans le district de Mambwe, et cela doit être effectué 2 semaines après le traitement avec Berenil pour réduire les coûts des trypanocides pour les éleveurs.

Abstract

Background: African Animal Trypanosomiasis (AAT) caused by Tsetse flies is a major constraint to livestock production in settled parts of tropical Africa. Zambia has not been spared as livestock farmers in affected areas are heavily dependent on use of drugs to manage the disease. However, for prophylaxis to be achieved administration of drugs must be done properly which is not the case in most remote setups.

Objective: To determine the efficacy of Samorin for prophylaxis in cattle in areas with different Tsetse infestation density.

Method: Three areas were purposely selected with 3 levels of infestation; low, medium and high. Monthly follow-ups where conducted for six months were animal blood samples from sentinel herds were analysed using Quantitative Buffy Coat, thick and thin smears and Packed Cell Volume.

Results: There was no significant difference in the period of efficacy of Samorin in the 3 selected areas of Mambwe district. Animals maintained the protective level of the prophylactic drug for the 6-month period.

Conclusion: Samorin to be administered once or twice per year in Mambwe district and this to be done 2 weeks after treatment with Berenil to reduce costs for farmers on trypanocide purchase.

Introduction

- La trypanosomiase humaine africaine (THA) est une zoonose et reste un important problème de santé publique en Afrique.
- Les gouvernements des pays affectés n'ont pas mis au point de politiques mûrement réfléchies pour gérer la plupart des maladies, y compris la THA (Simarro et al, 2011).
- L'OMS estime que plus de 70 millions de personnes sont exposées à la maladie, et seule une petite fraction est sous surveillance.
- La Zambie ne dispose pas de structure spécialisée pour la surveillance ou le contrôle de la THA dans les zones affectées (Mwanakasale et al, 2011;

Mulenga et al, 2015).

- En 2014, le district de Rufunsa en Zambie a signalé à lui seul neuf nouveaux cas (University of Zambia, 2014), suscitant ainsi beaucoup d'inquiétudes

Objective

- Faire des investigations et comparer les capacités de diagnostic et de gestion de la THA dans les centres de santé situés dans les districts de Chama et Mambwe infestés de glossines dans l'Est de la Zambie.

Methodolody

- Des questionnaires structurés ont été utilisés pour recueillir l'information auprès de 110 agents de santé issus de 23 RHC dans une étude comparative transversale réalisée entre avril et juillet 2013.
- Au moins 50% de l'ensemble du personnel présent issus des districts échantillonnés ont été captured, mais en raison du faible niveau de dotation, 79% et 80% du personnel des districts de Chama et Mambwe ont été captured.
- Stata/SE version 11.0 a été utilisée pour analyser les données collectées.

Results

- Occasions manquées de détecter la THA par rapport aux cas de paludisme dans les districts de Chama et Mambwe (P = 0,027).
- Le personnel des deux districts avait une préférence pour la détection d'affections liées à la fièvre plutôt que la THA tel que revu dans la direction de la plupart des services gouvernementaux et privés (P =0,007).
- Le personnel du district de Chama était plus susceptibles de détecter les cas de THA par rapport à leurs homologues de Mambwe (P <0,001) en raison de cas signalés précédemment.

Discussion

- Occasions manquées de détecter la THA par rapport aux cas de paludisme dans les districts de Chama et Mambwe (P = 0,027).
- Le personnel des deux districts avait une préférence pour la détection d'affections liées à la fièvre plutôt que la THA tel que revu dans la direction de la plupart des services gouvernementaux et privés (P =0,007).

- Le personnel du district de Chama était plus susceptibles de détecter les cas de THA par rapport à leurs homologues de Mambwe (P <0,001) en raison de cas signalés précédemment.

Conclusion

- La THA a de graves conséquences sociales et économiques, qui dépassent de loin le coût du maintien des activités de surveillance.
- L'élimination de la THA est techniquement réalisable et économiquement justifiable comme l'une des premières étapes importantes dans les efforts africains d'atténuation de la pauvreté.

Recommendations

- Formation continue dans la prise en charge de la THA pour les prestatiares de soins de santé dans les zones où la maladie est endémique ;
- Des lignes directrices stratégiques normalisées doivent être distribuées aux RHC pour guider la prestation de services par rapport à la THA ;
- Disponibilité d'outils de diagnostic appropriés pour la détection de la THA ;
- Intégration des activités de contrôle dans des réformes des systèmes de santé élargis.

GLOSSINA, BIOLOGY AND CONTROL/ BIOLOGIE, CONTROLE ET ERADICATION DES GLOSSINES

RÉPARTITION SPATIALE ET INFECTION À TRYPANOSOMES DES MOUCHES TSÉ-TSÉ DANS LA ZONE DE LA MALADIE DU SOMMEIL DU DISTRICT D'HURUNGWE AU ZIMBABWE

SPATIAL DISTRIBUTION AND TRYPANOSOME INFECTION OF TSETSE FLIES IN THE SLEEPING SICKNESS FOCUS OF ZIMBABWE IN HURUNGWE DISTRICT

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Résumé

Au Zimbabwe, les cas de trypanosomiase humaine africaine (THA) sont causés par Trypanosoma brucei rhodesiense. Les trypanosomes transmis par la mouche tsé-tsé, en particulier T. congolense et T. vivax, sont également sources de morbidité et de mortalité chez les animaux. Deux espèces de glossines, Glossina morsistans morsitans et G. pallidipes, sont présentes dans la vallée du Zambezi. Le but de l'étude était de donner un aperçu de la dynamique des mouches tsé-tsé et de la trypanosomose chez les humains et les animaux. La distribution de la mouche tsé-tsé et les infections à trypanosome ont été étudiées à l'aide de pièges et de fixed fly rounds situés à des intervalles de 10 km le long d'un transect de 110 km de longueur à cheval sur l'escarpement sud de la vallée du Zambèze. Des fly rounds de trois kilomètres de long ont été menées sur 12 sites et ont été répétés 11 fois sur une période de 7 mois. Un examen microscopique de 2092 mouches visant à détecter la présence de trypanosomes a été effectué. Les enquêtes menées ont confirmé la présence de G. morstein et G. pallidipes au fond de la vallée du Zambèze. Vers le sud, la densité apparente de la mouche tsétsé a atteint un point culminant au voisinage de l'escarpement, puis a chuté sur les hauts plateaux. Une seule mouche a été prise au sud de la vieille clôture de gibier. Un taux d'infection à trypanosome de 6,31% a été noté dans des mouches disséquées. Une seule infection par T. brucei a été détectée. La distribution de la mouche tsé-tsé dans la zone d'étude semble être influencée par des facteurs écologiques tels que l'utilisation des

terres et les modèles climatiques liés à l'altitude. L'étude confirme l'utilité de recueillir et d'analyser des informations spatialement explicites sur la trypanosomiase africaine. Au plan contextuel, cette étude a des implications politiques considérables dans l'identification de zones appropriées pour les interventions de contrôle de la mouche tsé-tsé. Les interventions ciblées peuvent maximiser les ratios avantages-coûts dans les programmes intégrés de lutte contre la mouche tsé-tsé, la THA et la TAA.

Mots-clés : tsé-tsé, Glossina, maladie du sommeil, trypanosomiase humaine africaine, Zimbabwe, Trypanosome

Abstract

In Zimbabwe, cases of human African trypanosomiasis (HAT) are caused by Trypanosoma brucei rhodesiense. Tsetse-transmitted trypanosomes, particularly T. congolense and T. vivax, also cause morbidity and mortality in livestock. Two tsetse species, Glossina morsistans morsitans and G. pallidipes, are present in the Zambezi Valley. The study aimed to provide insight into the dynamics of tsetse and trypanosomiasis in humans and livestock. Tsetse distribution and trypanosome infections were studied using traps and fixed fly rounds located at 10 km intervals along a 110 km long transect straddling the southern escarpment of the Zambezi Valley. Three km long fly rounds were conducted on 12 sites, and were repeated 11 times over a 7-month period. Microscopic examination of 2092 flies for trypanosome infections was conducted. Surveys confirmed presence of G. m.morsitans and G. pallidipes in the Zambezi Valley floor. Moving south, the apparent density of tsetse peaked in the vicinity of the escarpment, then dropped on the highlands. Only one fly was caught south of the old game fence. A trypanosome infection rate of 6.31% was recorded in dissected flies. Only one T. brucei-type infection was detected. Tsetse distribution in the study area appears to be driven by ecological factors such as land use and altitude-mediated climatic patterns. The study confirms the sefulness of collecting and analysing spatiallyexplicit information on African trypanosomiasis. Contextually, this study has considerable policy implications in identification of appropriate areas for tsetse control interventions. Targeted interventions can maximise the benefit-cost ratios in integrated programmes against tsetse, HAT and AAT.

Keywords: Tsetse, Glossina, Sleeping sickness, human African trypanosomiasis, Zimbabwe, Trypanosome

Background

Tsetse flies (Diptera: Glossinidae) are the vectors of both human and animal trypanosomiasis, which continue to impose a heavy burden on human and livestock health in sub-Saharan Africa [1]. Thirty-one species and subspecies of tsetse flies inhabit approximately 11 million km2 between 15°N and 29°S [2, 3]. Of the 31 species, two of the savannah group are found in Zimbabwe:

Glossina morsitans morsitans and Glossina pallidipes. Half the area of Zimbabwe below 1000 m altitude (approximately 200,000 km2) is considered ecologically suitable for tsetse flies and therefore it was historically unsuitable for livestock rearing. Following the rinderpest epidemic in 1896, tsetse flies disappeared from the banks of the Zambezi River between Victoria Falls and the Gwayi River [4, 5]. Furthermore, subsequent tsetse control operations using a combination of techniques such as ground spraying, aerial spraying and bait-technologies (insecticide-treated cattle and targets), reduced the area of tsetse habitat to the present level (approximately 30,000 km2). The tsetse flies distribution in Zimbabwe is presently mainly restricted to the northern districts along the Zambezi Valley.

In our study area, (Hurungwe District, northern Zimbabwe), major tsetse control operations using insecticide-treated and odour-baited targets were discontinued in 2001. Since then, no major control activities have been implemented in the area south of the game fence, separating protected and settled areas except cattle dipping with deltamethrin. The formulation used is effective in controlling ticks as well as tsetse flies. Dipping of cattle is conducted fortnightly during the dry season (May to October) and weekly during the rainy season (November to April). Cases of trypanosomiasis in livestock are diagnosed at dip tanks during regular monitoring surveys.

The present study sought to explore the spatial distribution and trypanosome infection rates of tsetse flies in the human African trypanosomiasis (HAT) endemic area of Zimbabwe (Hurungwe district). In parts of this area the tsetse fly habitat has been modified through deforestation and the expansion of agriculture. These changes necessitated reassessment of tsetse fly distribution patterns in the area. At the national level, the Tsetse Control Division in Zimbabwe has recently embarked on the development of a National Atlas of tsetse flies and African animal trypanosomiasis (AAT), to which the present study will contribute. The Atlas will broadly follow the methodologies developed by the Food and Agriculture Organization of the United Nations (FAO) for the continental Atlas of tsetse flies and AAT [6, 7]. It will also draw upon the example of other national-level Atlases, such as the one recently developed in Sudan [8].

The present study was also necessitated by the upsurge in HAT cases that were reported in 2012 [9], and the need to explore its causes. No case of HAT was reported in Zimbabwe between 1998 and 2004 [9]. By contrast, 28 cases and three deaths were recorded between 2005 and 2015, all originating from the Hurungwe District and neighbouring areas. Little is known of thecauses of the observed resurgence of the disease in the past decade. Reported cases include local inhabitants and foreign travellers [10, 11], together with cases reported from neighbouring areas in Zambia [10]. Many infections in Zimbabwe were detected in tourists who visited the Zambezi Valley, as well as in game park rangers who spend much of their time in tsetse fly habitat. Furthermore, limited diagnostic capacity for HAT in the national health system is likely to result in important levels of under detection, thus distorting the true epidemiological situation.

Methods

Study area

The surveys presented in this paper were conducted in the Hurungwe District (Mashonaland West Province, northern Zimbabwe; Fig. 1). In particular, a 110 km long transect was investigated, intersecting the southern escarpment of the Zambezi Valley. The lowlands north of the escarpment are protected areas and are home to a rich variety of wild animals, including elephant, buffalo, impala, warthog and cheetah. In this environment, wildlife provides the main source of blood meals for tsetse flies. The main tree species are Colophospermum mopani, Acacia nigrescens, and Adansonia digitata. The area is also characterized by a dense undergrowth of deciduous bushes [12]. On the highlands south of the escarpment, land use is characterised by mixed crop agriculture, livestock and by higher human population densities. Until recently, a game fence physically marked the boundary between the protected and settled areas.

This fence is no longer regularly maintained along its length, but still represents the administrative limit of the protected areas. As such, it continues to mark a sharp discontinuity in land use. The study was conducted over the four seasons (hot-dry, warm-wet, cool-wet, and cooldry) in Zimbabwe.

Design of tsetse surveys

Transect design

A transect from the floor of the Zambezi Valley (at an altitude of approximately 400 m), up the escarpment and ending on the highlands (at approximately 1200 m) was used for the survey. A random start point was selected for the first sampling location and an interval of10 km was used for subsequent

locations, providing a total of 12 sampling sites along the transect (Fig. 1). A combination of blue/black/blue-screen fly rounds [13, 14] and Epsilon traps were used for sampling.

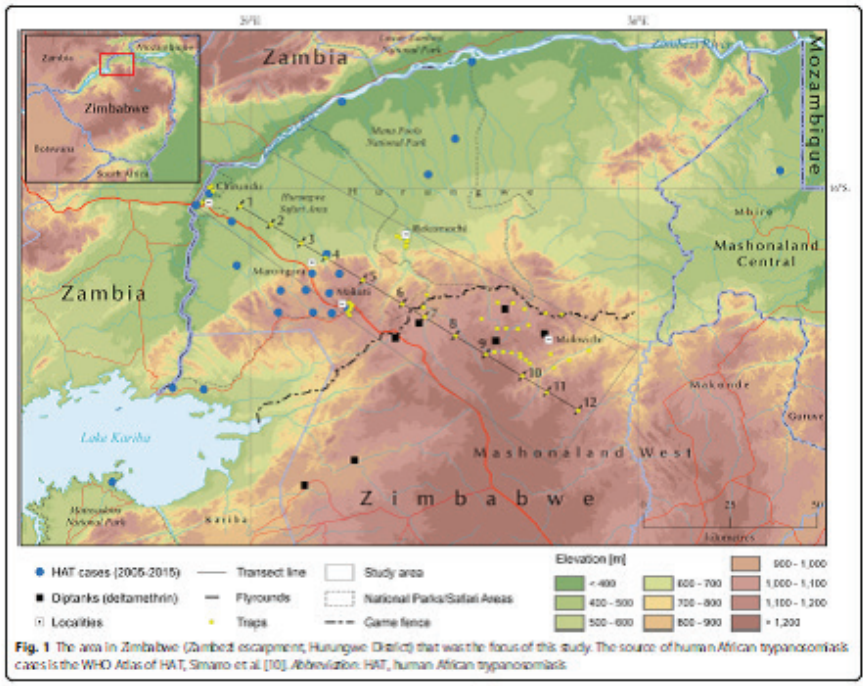


Fig. 1 The area in Zimbabwe (Zambezi escarpment, Hurungwe District) that was the focus of this study. The source of human African trypanosomiasis cases is the WHO Atlas of HAT, Simarro et al. [10]. *Abbreviation*: HAT, human African trypanosomiasis

Screen fly rounds

For each of the 12 sampling sites a 3 km long fly round perpendicular to the transect was carried out. Each fly round was divided into equal sectors of 100 m, which were marked on the ground with white paint. Geographical coordinates were systematically measured with the global positioning system (GPS). Fly rounds involved the use of a blue/black/blue screen attached to an aluminium pole that was baited with tsetse fly odour attractants (3-n propyl phenol, 1-octen-3-ol, 4-methyl phenol). The screen was carried by two men equipped with fly nets for catching all the flies landing on the screen [15]. The surveys were conducted simultaneously on all fly rounds for 5 h (from 08:00 to 10:30 h in the morning and from 14:00 to 16:30 h in the afternoon), taking into consideration the bimodal pattern of tsetse fly activity [16]. Some of our teams were working in National Park areas and limited transport prompted us to end the fly rounds at 16:30 h. This decision was mainly to allow teams to be retrieved from the park before it was dark to avoid encounters with wildlife after sunset. Eleven sessions, with each comprising two fly rounds, one conducted in the morning and the other in the afternoon of each sampling day, were simultaneously conducted at each of the 12 sites, starting on 26

February and ending on 18 November 2014. The study period covered both dry and rainy seasons.

Transect traps

In addition to fly rounds, stationary traps (Epsilon traps) were used to monitor tsetse flies along the transect. Two traps were deployed at each of the 12 sites where fly rounds were conducted. In particular, at each site one trap was located at the exact intersection between the transect line and the fly round line, while the second trap was deployed at a distance of 100 m from the intersection.

Efforts were made to optimize trap visibility, by choosing more open sites where traps were not obscured by dense vegetation [17]. The 1 m radius clearings sites south of the game fence. In fact, only one fly (G. m. morsitans) was caught south of the fence. In terms of apparent density, the findings in the additional traps are also consistent with the results from the transect (both fly rounds and traps). In particular, the highest densities were detected at the foot of the escarpment (Rekomechi and Marongora sites).

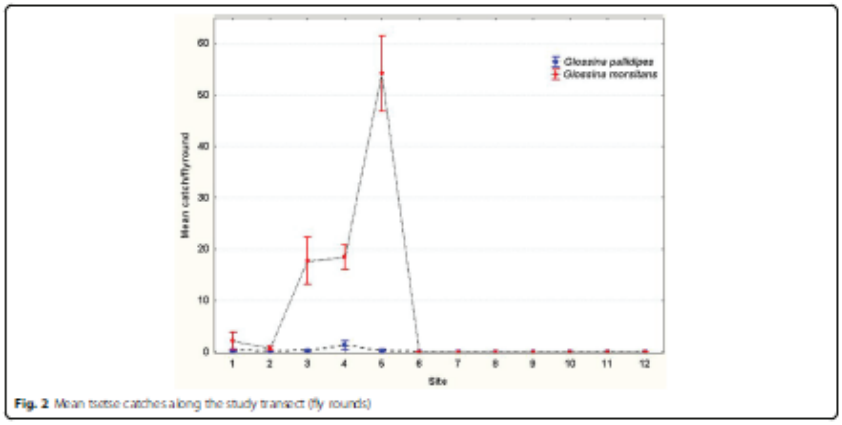


Fig. 2 Mean tsetse catches along the study transect (fly rounds)

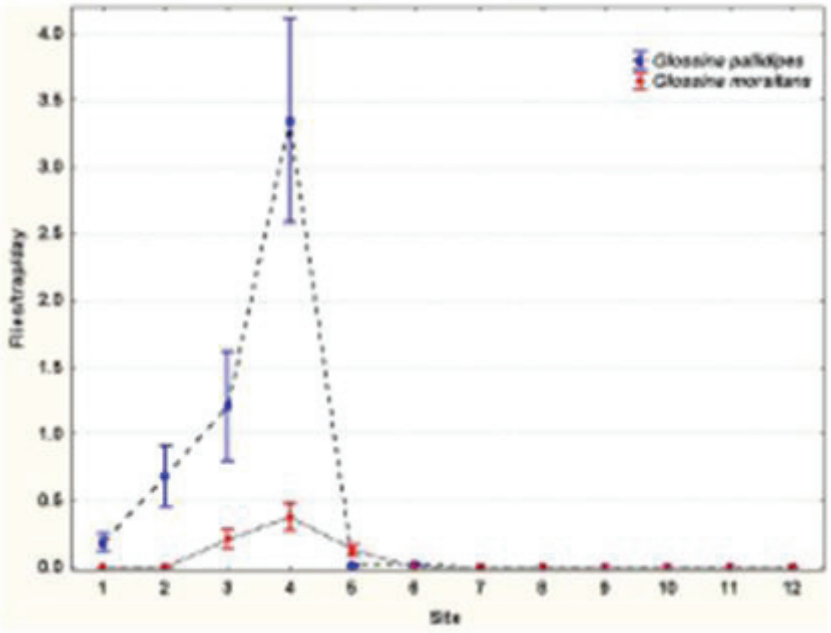
Tsetse infection

Dissection of 2092 flies yielded only one positive infection of the T. brucei-type, while a number of T. vivax-type and T. congolense-type infections were identified (85 and 46, respectively). Both sexes of G. m. morsitans and G. pallidipes were dissected. A mean infection rate of 6.31% was found (132/2092). Infection rates were higher in males of both tsetse fly species than in females (7.32 and 5.28%, respectively) although statistically insignificantly higher (t-test: $t(40) = 1.0482$, $P = 0.3008$). The infection rates did not differ significantly between the transect traps/fly rounds and traps deployed at

Rukomechi Research Station (t-test: t(4) = 1.1485, P = 0.3147).

Shapiro-Wilk normality test resulted in P-values of 0.901 for Rukomechi infection rate and 0.9824 for transect indicating that data followed a normal distribution.

The results of tsetse examinations are summarized in Table 1.



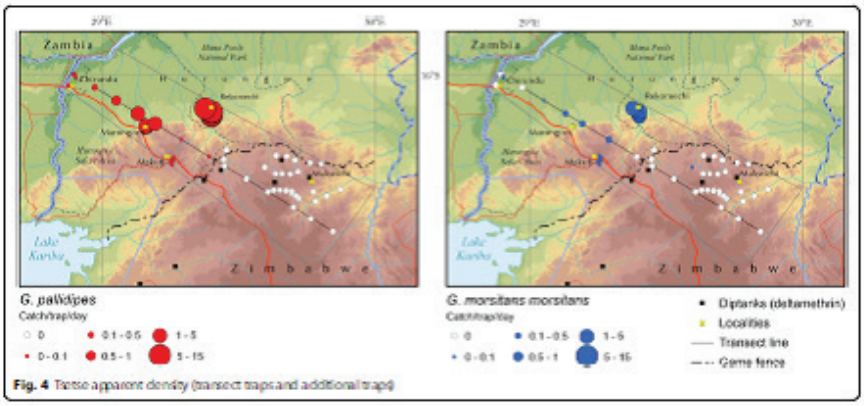


Fig. 4 Tsetse apparent density (transect traps and additional traps)

0.901 for Rukomechi infection rate and 0.9824 for transect indicating that data followed a normal distribution.

The results of tsetse examinations are summarized in Table 1.

Discussion

The entomological surveys presented in this paper provide insights into the geographical distribution of tsetseflies in the sleeping sickness region of Zimbabwe (Hurungwe District). The game fence marking the limit between the protected and the settled areas appears to mark the southern limit of the tsetse fly distribution.

This land use discontinuity is also associated with an abrupt topographic and ecological transition, i.e. the escarpment of the Zambezi Valley. All entomological findings confirmed that G. morsitans morsitans and G. pallidipes are present at varying densities from the Zambezi Valley floor to the top of the escarpment.

Proceeding further south across the highlands, the tsetse fly infested area stretches to the game fence that marks the beginning of the settled and intensely cultivated area.

The settled area presently appears fundamentally unsuitable for tsetse flies, although occasional incursions or relic populations may occur, as demonstrated by the one fly (G. m. morsitans) captured south of the fence in one of the 'additional traps'. The presence of tsetse flies in the protected areas is consistent with the reported occurrence of HAT cases, which seem to be mainly linked to a wildlife reservoir of T. b. rhodesiense [7, 10]. As documented elsewhere [23, 24], the geographical interface between protected and settled areas appears to be one of the main areas where vectors (tsetse), parasites (trypanosomes) and susceptible hosts (humans and livestock) come together.

In view of the tsetse fly control operations which were discontinued approximately 15 years ago, and the land cover changes reported to have occurred in the intervening time, further studies are suggested to explore how the interplay between tsetse fly control and ecosystem change in the recent past may have shaped the present observed distribution of tsetse.

Within the tsetse fly infested area, very large differences in fly densities were observed, with peaks in the areas adjacent to the escarpment of the Zambezi Valley. The factors affecting these differences are not yet fully understood, but they are likely to be related to macro- and micro-climatic patterns and the availability of game hosts [25, 26]. Fine scale differences in vegetation cover, driven, for example, by the pattern of the hydrological network, may be playing a key role. In particular, watering points near the escarpment may provide both hosts and favourable microhabitat for tsetse flies.

Table 1 Tsetse trypanosome infections detected by fly dissection and microscopic examination [19]

Location	No. of flies	*T. vivax*-type		*T. congolense*-type		*T. brucei*-type		Total	
		n	%	*n*	%	*n*	%	*n*	%
Transect traps and fly rounds	92	4	4.35	3	3.26	0	0	7	7.61
Additional traps (Rukomechi)	2000	81	4.05	43	2.15	1	0.05	125	6.25
Total	2092	85	4.06	46	2.20	1	0.05	132	6.31

The study also confirmed how the efficiency of fly rounds and traps differs greatly between the two species.

G.m. morsitans are more attracted to mobile baits (fly rounds) while G. pallidipes are more attracted to stationary baits (traps) [27, 28] The bimodal pattern of tsetse fly diurnal activity was also confirmed, with no significant difference detected between the morning and afternoon fly rounds [16].

Results of tsetse fly dissections revealed a very low level of infections of the T. brucei-type. This finding seems to be consistent with a HAT epidemiological situation that is generally considered to be low risk [29]. On the other hand, molecular analysis using PCR on 209 flies collected during the same transect surveys revealed a higher prevalence (14.8%) of T. brucei DNA, although none of these tested positive for T. b. rhodesiense DNA (Goodwin et al., unpublished). This is due to the detection of both mature and immature trypanosome infections in the mid-gut and salivary glands. The detailed results of this molecular analysis will be published elsewhere.

The generally positive epidemiological picture or low prevalence of the disease emerging from these entomological

surveys must be interpreted in the light of a low capacity for HAT diagnosis, especially in the endemic zones. Human African trypanosomiasis infections contracted in Zimbabwe are diagnosed almost exclusively in Harare or abroad [8, 11], and it is reasonable to speculate that many cases may go undetected. Efforts must be made to bring capacities for sleeping sickness diagnosis closer to the endemic areas and therefore reduce the travel time to equipped health

facilities [27, 30]. A strengthened capacity for HAT detection would enable a more realistic estimation of the burden of the disease, and it would also contribute to tackling it more effectively. Also, the transboundary nature of the tsetse and trypanosomiasis problem calls for coordinated multinational actions, which in this particular case could involve Zimbabwe, Zambia and Mozambique. In areas within Zimbabwe that are affected by HAT (e.g. in safari hunting areas,), collaborative programmes with the relevant institutions should be prioritised. One such joint programme is currently underway with National Parks and Wildlife management to control tsetse in Hurungwe safari area.

Conclusions

The present study confirms the usefulness of collecting and analysing spatially-explicit information on African trypanosomiasis, including entomological and parasitological data. For the future, more systematic data management and mapping at the national level is believed to be crucial for an evidence-based decision making in field interventions.

Long-term, geo-referenced data assemblies such as the one envisaged by the national Atlas of tsetse and AAT in Zimbabwe will be a prerequisite for investigating some of the epidemiological dynamics discussed in this paper (for example, the virtual disappearance of tsetse flies from areas south of the game fence). Elucidating the interplay between tsetse fly control and ecosystem and climatic changes in this area could help optimize tsetse control and elimination strategies in other zones in Zimbabwe and elsewhere.

Concerning the risk of sleeping sickness, the present study revealed an entomological situation that is consistent with the picture emerging from the reported HAT cases. In particular, infections seem to occur primarily in the protected, wildlife-rich areas with high tsetse fly density. Trypanosome infections of tsetse flies do not seem to indicate an alarming HAT risk situation. However, it must be noted that the relation between tsetse infection rates and HAT occurrence is a complex one, and a low HAT risk cannot be directly inferred from low infection rates in tsetse.

In the Hurungwe District, One Health approaches including targeted tsetse fly control have the potential to contribute to the reduction of both human and animal trypanosomiasis. In this context, the current study has considerable policy implications for Zimbabwe. In fact, while in the past control measures could target large swathes for tsetse eradication, only small and isolated patches of risk may be treated and targeted for elimination today. In these cases, the degree of isolation of these the target populations would need to be evaluated

[31] to ensure sustainability. Targeted interventions can maximise the benefit-cost ratios in the present challenging economic context, and investment in integrated interventions against tsetse, HAT and AAT may hold the greatest potential. Importantly, while the overall longterm objective is the complete elimination of tsetse and trypanosomiasis from the entire country, because of resource constraints, the areas posing the greatest risk of HAT and AAT need to be prioritised.

Abbreviations

AAT: Animal African trypanosomiasis; ANOVA: Analysis of variance; CASS: Centre for Applied Social Sciences; DDDAC: Dynamic Drivers for Disease in Africa Consortium; DFID: Department for International Development; EIDC: Environmental Information Data Centre; ESPA: Ecosystem Services for Poverty Alleviation; ESRC: Economic and Social Research Council; FAO: Food and Agriculture Organization of the United Nations; GPS: Global positioning system; HAT: Human African trypanosomiasis; NEPAD: New Partnership for Africa's Development; NERC: Natural Environment Research Council; PAAT: Programme against African trypanosomosis; WHO: World Health Organization; WHO/TDR: World Health Organization/ Tropical Disease Research

CHANGEMENT DE LA SITUATION DES GLOSSINES ET DE LA TRYPANOSOMIASIS PENDANT LA PÉRIODE 1987 - 2015 DANS UNE ZONE DE 1 800 KM2 DE LA ZAMBIE ORIENTALE SOUMISE À UN CONTROLE DE LA MOUCHE TSETSE UTILISANT DES CIBLES APPATES OLFACTIVES DE 1986 À 1999

CHANGE IN THE TSETSE AND TRYPANOSOMIASIS SITUATION DURING THE PERIOD 1987 TO 2015 IN A 1,800KM2 AREA IN EASTERN ZAMBIA SUBJECTED TO TSETSE CONTROL WITH ODOUR-BAITED TARGETS FROM 1986 TO 1999

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Résumé

À la fin des années 1980, la ceinture orientale des glossines en Zambie était estimée à environ 127 000 km2 - parties des provinces Est, Muchinga, Centre et Lusaka. La ceinture s'étend également à trois pays voisins, à savoir le Malawi, le Mozambique et le Zimbabwe, et ceci a servi de base à la création du Programme régional de lutte contre la mouche tsé-tsé et la trypanosomiase (RTTCP) grâce au financement de la Communauté économique européenne (l'actuelle Union européenne - UE), dans le but d'éradiquer la mouche tsé-tsé de cette ceinture. En Zambie, le RTTCP a mis en oeuvre des opérations de contrôle de la mouche tsé-tsé dans deux blocs couvrant environ 1800 km2 pendant la période 1988-1999, comme essai destiné à tester l'efficacité des cibles appâtées olfactives. Des enquêtes sur la mouche tsé-tsé et la trypanosomiase (chez les bovins) ont été effectuées en conséquence, c'est-à-dire au départ et tout au long des opérations. À l'intérieur de la zone de contrôle, les résultats ont montré que les opérations avaient effectivement réduit la densité apparente de la mouche tsé-tsé - de 25-60 mouches / fly-round en moyenne à zéro (0), et que la prévalence de la trypanosomose de 15 à 45% en moyenne à zéro (0). Cependant, les emplacements situés sur les bords et à l'extérieur de la zone de contrôle, en particulier dans les sections nordiques des blocs, ont continué à enregistrer la présence de la mouche tsé-tsé et la prévalence / incidence de la trypanosomiase.

Depuis l'interruption des opérations en 1999, le gouvernement a facilité, au fil des années, des enquêtes sur les glossines et la trypanosomose dans la région de temps en temps pour faciliter le suivi de la situation, et les dernières enquêtes de ce genre entreprises en 2015 n'ont pas permis de détecter la présence de

mouches tsé-tsé ou la prévalence de la trypanosomose dans et bien au-delà des limites de l'ancienne zone de contrôle des glossines. Le document examine les résultats d'enquête obtenus au cours des années et discute des résultats et des explications éventuelles.

Abstract

In the late 1980s the Eastern tsetse belt in Zambia was estimated to cover approximately 127,000 km2 - parts of the Eastern, Muchinga, Central, and Lusaka Provinces. The belt also extends into three of the country's neighbours, i.e. Malawi, Mozambique and Zimbabwe, and this was the basis for the creation of the Regional Tsetse and Trypanosomiasis Control Programme (RTTCP) through funding from the then European Economic Community (EEC) (now European Union (EU)), with the objective of eradicating tsetse flies from this belt. In Zambia, the RTTCP implemented tsetse control operations in two blocks covering about 1800km2 during the period 1988-1999 as a trial to test the effectiveness of odour-baited Targets. Tsetse and trypanosomiasis (in cattle) surveys were conducted accordingly - i.e. baseline and throughout the duration of the operations. Inside the control area, the results showed that the operations had effectively diminished the tsetse apparent density from 25-60 flies/flyround on average, to zero (0), and the trypanosomiasis prevalence from an average of 15 – 45% to zero (0). However, locations in the edges and outside the control area, particularly in the northern sections of the blocks, continued to record tsetse presence and prevalence/incidence of trypanosomiasis. Since discontinuity of the operations in 1999, the government has, over the years, has over the years facilitated tsetse and trypanosomiasis surveys in the area now and again to facilitate monitoring of the status, and the latest such surveys undertaken in 2015 did not detect any tsetse presence or prevalence of trypanosomiasis within and well beyond the boundaries of the former tsetse control area. The paper examines the survey results obtained over the years and, the results and possible explanations are discussed.

INTRODUCTION

In the 1980s and 90s, the European Economic Community (Now European Union) funded the Regional Tsetse and Trypanosomiasis Control Programme (RTTCP) that covered four countries in southern African, Malawi, Mozambique, Zambia and Zimbabwe. The main activities undertaken were tsetse and trypanosomiasis surveys, research work on particular aspects of the tsetse and trypanosomiasis problem, and tsetse control operation mainly with application of odour-baited targets. In Zambia, tsetse control operations took the form of trials to evaluate the performance of odour-baited targets in areas where the operations were also intended to significantly reduce the trypanosomiasis burden among farmers. One such tsetse control area was undertaken in the country's Eastern province, and by 1999 the total area

covered by the control operations with targets was estimated at 1,900km2 that covered parts of Petauke and Katete districts (Maps 1-3). The operations started with the RTTCP taking over a 400km2 tsetse control area (Matambazi area) located south-east of Petauke district that had been implemented by a Belgium-funded disease control project in 1988, and extension of the area westwards by another 500km2 (Mvuvye area) by the RTTCP, to bring total area to 900km2. In 1994, an additional 1,000km2 located north of the Mvuvye-Matamba zi area, was put under a community-based tsetse control operation (with application of odour-baited targets), in form of another trial. This brought the total area brought under the respective set of tsetse control operations with odour-baited targets, to 1,900km2.

In each of the three tsetse control areas (blocks), the project undertook baseline tsetse and trypanosomiasis surveys (prior to deployment of targets), and also tsetse and trypanosomiasis surveillance during the whole period that the area was under the respective tsetse control operations.

Tsetse control Targets were subjected to maintenance at intervals of 3 to 6 months. In the Mvuvye and Matambazi areas, maintenance of targets was undertaken by the project's field teams, made up of largely government technical tsetse control personnel and temporary (casual) workers locally recruited (in the operational areas). In the Msanzara area, the project provided the necessary materials and chemicals, and members of the community provided the labour in the maintenance of the targets with guidance provided by extension personnel from the project. By the end of 1999, the project's tsetse control operations, and tsetse and trypanosomiasis surveillance activities, had been discontinued.

In the year 2000, another tsetse control trial was implemented in the western part of the area subjected to the tsetse operations with application of odour-baited targets, and the trial involved application of pour insecticide on cattle. The operation was undertaken for a period of only one year, the year 2000.

No tsetse and/or trypanosomiasis survey was implemented in the area until 2004 when a trypanosomiasis survey was undertaken in the Msanzara area. In 2016, it was decided to undertake a tsetse and trypanosomiasis survey in the northern section of the respective RTTCP tsetse control areas, using the line that marked the location of a tsetse control game fence that was in place from the 1960s to the late 1970s, as reference line, to assess the status in the respective area considering the period that had passed since the tsetse control operations were discontinued in the late 1990s. This was also based on the fact that the Luangwa valley, located north of the particular area of interest, being

the source of tsetse reinvasion into the plateau areas – noting the non-existence of a natural or artificial barrier against tsetse movement in the respective area.

The paper looks at, and discusses, the trend over the years with regard to the tsetse and trypanosomiasis situation in the area, looking at the situation as indicated by the results of the baseline surveys in the control area, the status as established though the outcome of the trypanosomiasis survey conducted in 2004, and the results from the tsetse and trypanosomiasis survey undertaken in 2016.

TSETSE AND TRYPANOSOMIASIS SITUATION IN THE RTTCP TSETSE CONTROL BLOCKS (AREAS)

The Eastern Tsetse belt and Location of RTTCP tsetse control block (1988-99 As at 1988, the Eastern Tsetse belt in Zambia was estimated to cover 127,000 km2, covering parts of the Eastern, Muchinga, Central and Lusaka provinces (Fig 1). In the Eastern province, the core tsetse infestation (in the belt) has historically been in the Luangwa valley and extends into the adjacent plateau areas where human population, agricultural activity and hence cattle, were and are concentrated. In 1988, the tsetse infestation extended southwards (1988) to the border with Mozambique in the south-western section of the belt. The RTTCP tsetse control blocks were located in this south-western section of the eastern tsetse belt (Fig 1).

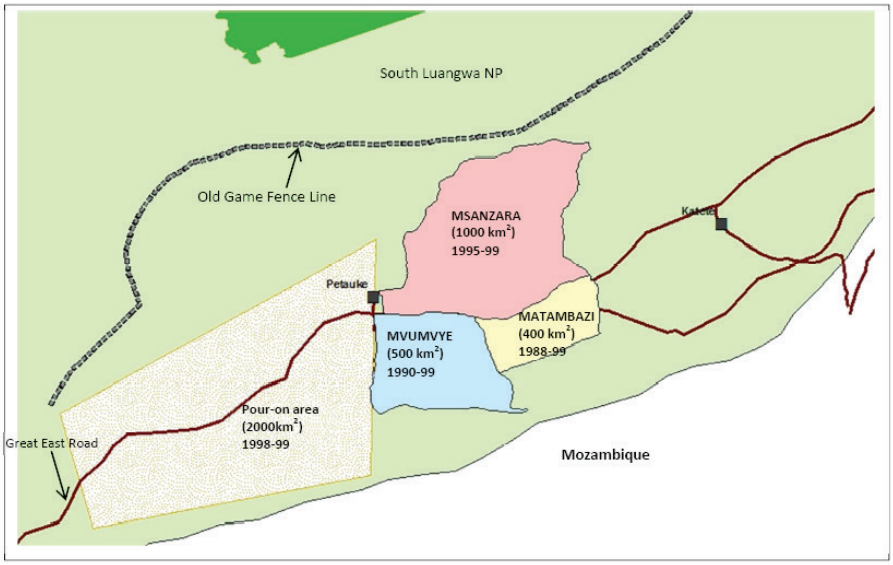


Figure 2. Location of the four tsetse control blocks under the RTTCP 1988-2000.

Baseline Tsetse and Trypanosomiasis Surveys in the Tsetse Control Blocks
Baseline surveys and surveillance, to establish the status in terms of tsetse Apparent Density and Trypanosomiasis Prevalence/incidence (in cattle) were undertaken in each of the control block prior to deployment of targets in the respective areas.

The results of the baseline surveillance activities, on average, were as indicated in figures 3a to 3c.

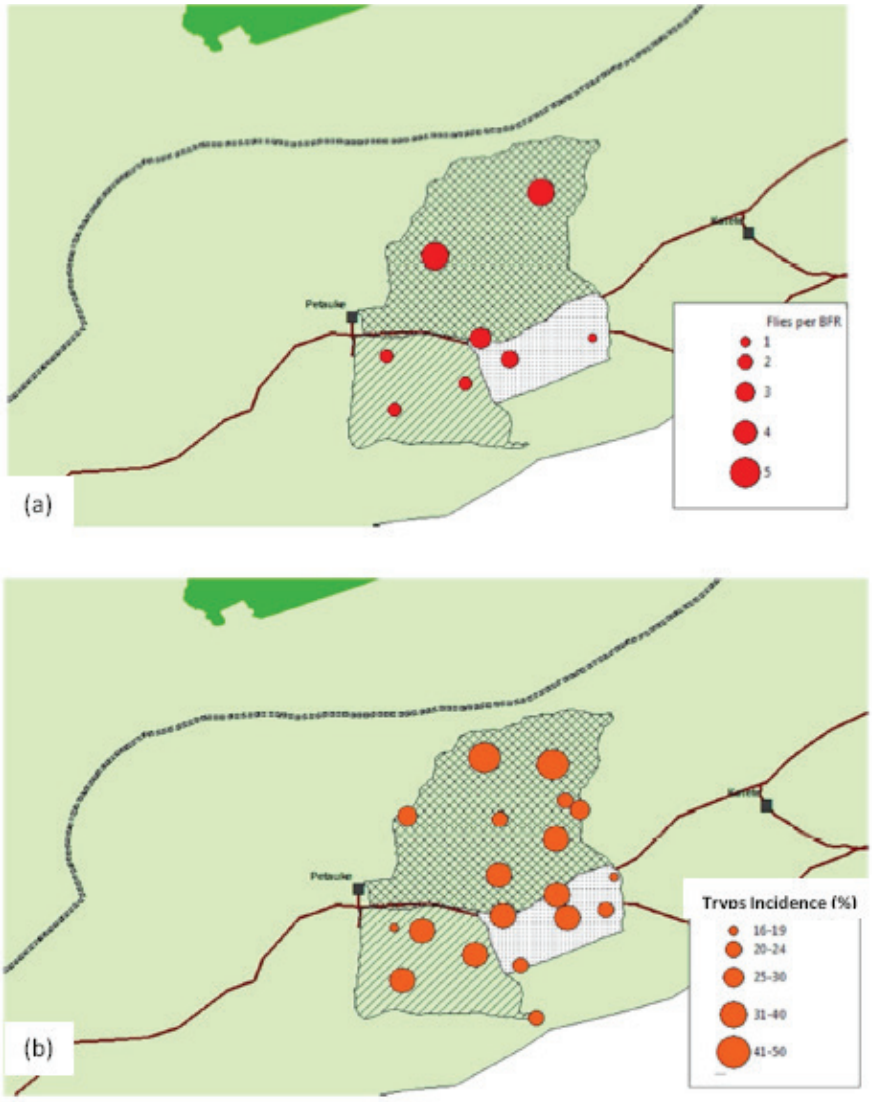


Figure 3. Baseline Tsetse Apparent Density & Trypanosomiasis Incidence in the tsetse control blocks

Surveillance results at time of discontinuation of the control operations

In each of the control blocks, Tsetse and Trypanosomiasis surveillance was undertaken during the duration of control operation. This was done monthly in the first year of the control operation, and later changed to 3-4 month intervals in the latter years of the tsetse control operations.

The outcome from the surveillance activities in the months just before the operations were discontinued, were as given in figures 4a to 4c.

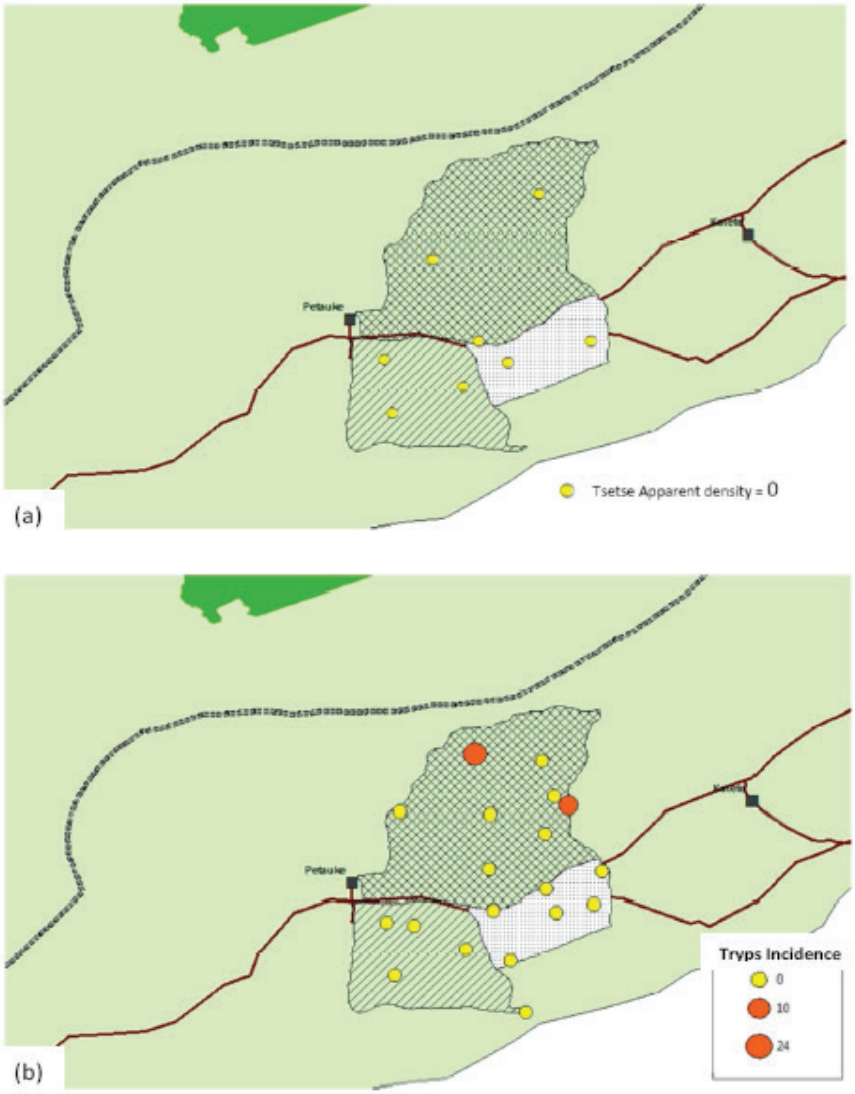


Figure 4. Tsetse Apparent Density & Trypanosomiasis Incidence in the tsetse control blocks in 1998/99

Trypanosomiasis survey in the Msanzara area in 2001

In 2001, a trypanosomiasis survey was undertaken in the Msanzara area, the area in which the RTTCP implemented the community-based tsetse control operation – with the objective of checking the status 2 years after the community –based tsetse control operation was discontinued in the area.

The results of the survey were as given in figure 5.

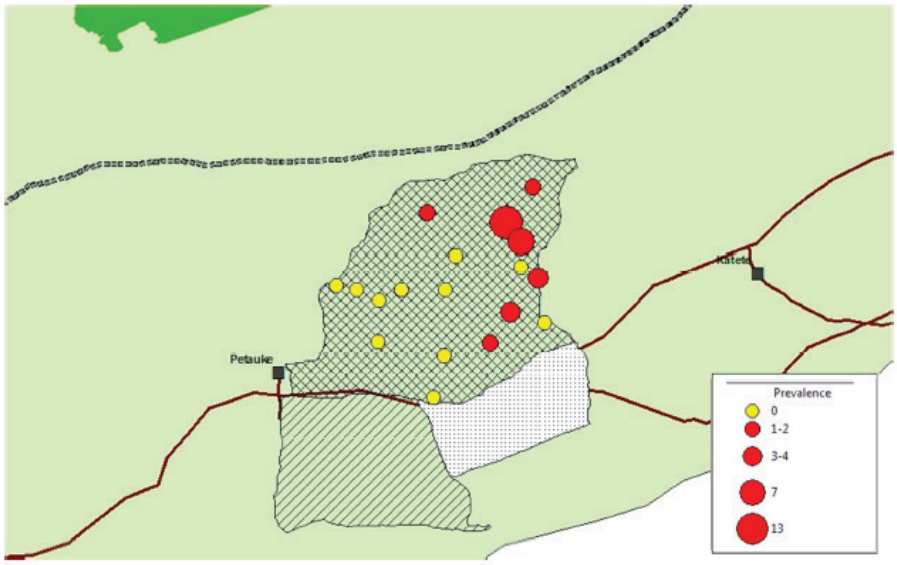


Figure 5. Trypanosomiasis Prevalence in the Msanzara area in 2001

Tsetse and Trypansomiasis survey in 2016

As part of a process to prepare a strategy on control of tsetse and trypanosomiasis in the country's Eastern Tsetse Belt, a tsetse and trypanosomiasis survey was conducted, in 2016, in a band of area about 200km long and 20-30km north and south of the line that marked the location of the old tsetse control game fence indicated above. Figure 6 shows the results obtained from the survey.

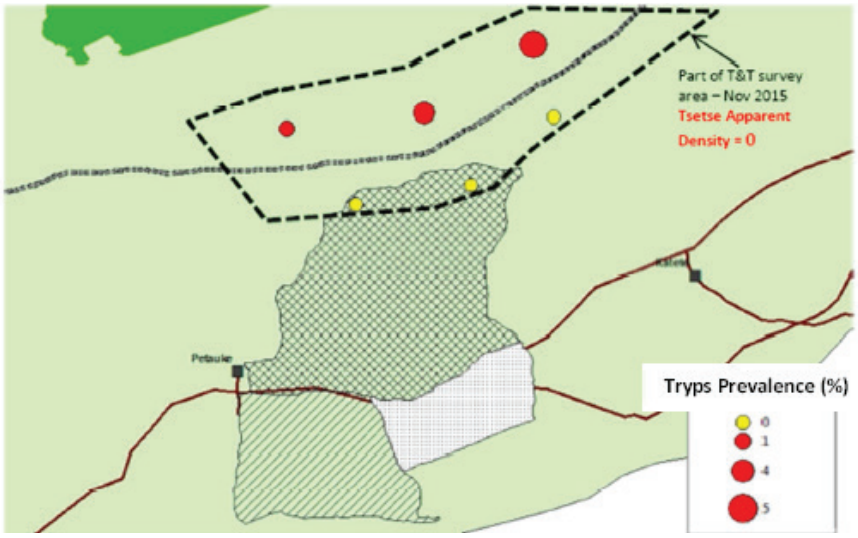


Figure 6. Results - Tsetse and Trypanosomiasis Survey conducted in 2015

DISCUSSION

The findings through the surveillance work undertaken before (baseline) and at the end of the tsetse control operations indicated effective performance of the tsetse control operations (with application of odour-baited targets) such that only the northern and north-eastern most sections of the Msanzara area, i.e. the tsetse reinvasion front, had continued to record incidence of trypanosomiasis as at 198/99 (Figure 4). As at 2001, the indication was that the trypanosomiasis situation had deteriorated in the respective parts (sections) of the Msanzara area (Figure 5).

The surveys conducted in 2015, however, did not detect any presence tsetse flies or prevalence of trypanosomiasis in locations south of the line (road) that marked the location of the old tsetse control game fence – i.e. in the area that included the whole of the area that had been under the RTTCP tsetse control operations from 1988 to 1999 (Figure 6). This outcome, if at all it reflected the true status in the area, was quite unexpected, particularly considering that no tsetse control operation had been undertaken in the area since 1999/2000, and also noting the status in the area as it was in 1998/99 and in 2001 (Figures 4 and 5).

What could be the explanation for the situation as indicated by the outcome of the tsetse and trypanosomiasis survey of 2015? The following could be hypoothesised;

(a) Increase in human population density leading to increase in area under arable agriculture, and consequently giving rise to significant degradation of tsetse habitat, particular in the period after 1999. This could in turn be associated, at least partly, with the reduction/elimination of the trypanosomiasis burden and risk in the area covered by the RTTCP tsetse control operations particularly in the Msanzara area where the period during and after the operation saw significant migration of people and cattle from areas close to the Mozambique border to the northern sections of the Msanzara area. Such degradation of habitat could have entailed reduction or shrinking of the tsetse belt such that southern edge of the tsetse belt may have gradually shifted northwards to locations closer to the Luangwa valley – as suggested by the outcome of the 2015 survey results (Figure 6).

(b) After the RTTCP tsetse control operations, the tsetse population density, particularly in the northern and north-eastern sections of the Msanzara area, could have remained very low over the year till 2015, probably with contribution of detrimental changes in environmental conditions (as in item (a) above), leading to diminished capacity/prospects for increase in tsetse population density in the area, but the environment still have been adequately sustained survival of some tsetse flies in the area. However, the tsetse population density may have remained so low that the sampling tools and method applied in the 2015 survey (extensive survey) may not have been able to detect the flies, and/or associated occurrence of trypanosomiasis, in the area. In such a situation, use of trypanocides in cattle may have further diminished chances of detecting trypanosomiasis cases in the area.

With regard to the way forward, it would of benefit to have a more detailed (intensive) tsetse and trypanosomiasis survey undertaken in the respective area, to check/verify presence/absence of tsetse flies and trypanosomiasis. Further, it would be useful to undertake assessment of change in human and livestock population density in the area, and also land cover/use change in the respective area during the period 2000 to date. This could help ascertain whether or not the survey results obtained in 2015 indeed present a true picture of the tsetse and trypanosomiasis situation in the respective area, and what factors may have contribute to an explanation of the prevailing tsetse and trypanosomiasis situation as it may currently be in the area.

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L'ÉVALUATION DES REPULSIFS DE LA MOUCHE TSETSE AVANT LA COMMERCIALISATION ET LA LIBÉRATION POUR 'UTILISATION DE MASSE DANS LA GESTION DE LA TRYPANOSOMIASE AU KENYA

EVALUATION OF TSETSE FLIES REPELLENTS PRIOR TO COMMERCIALISATION AND MASS RELEASE FOR USE ON MANAGEMENT OF TRYPANOSOMIASIS IN KENYA

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Abstract

Several products including insecticides and traps for tsetse flies control and management of Animal Trypanosomiasis are today commercially produced and available in the market. There are other products that have been researched on but are unavailable to the farmers due to lack of clear processes of commercialisation before availing them to stakeholders through Research-Private Institutions venture. Since the year 2005, International Centre for Insect physiology and Ecology (icipe) has been researching on repellents for tsetse flies extracted from Waterbuck (Kobus ellipsiprymnus) and refining the collar dispensers. However, the release of the repellents for use by farmers is legally not allowed in Kenya without undertaking its' efficacy trial by the appointed regulator of pest control products. As a legal requirement prior to commercialisation, an evaluation study was undertaken to evaluate the protection the repellents produced by icipe would confer to the livestock against trypanosomiasis under field conditions. The efficacy trials were conducted in Shimba Hills of Kwale County, Kenya. Three differently treated experimental herds and in replicate, each with seven animals, totalling to 42, were selected for the trials. Biconical traps were used to monitor tsetse flies. The data obtained was then subjected to statistical analysis for any significance.

Résumé

Plusieurs produits, dont des insecticides et pièges pour le contrôle de la mouche tsé-tsé et la gestion de la trypanosomiase animale sont actuellement commercialisés et disponibles sur le marché. Il existe d'autres produits qui ont fait l'objet de recherches, mais qui ne sont pas disponibles pour les éleveurs

en raison du manque de processus de commercialisation clairs avant leur mise à la disposition des parties intéressées par le biais d'entreprises mixtes instituts de recherche/institutions privées. Depuis 2005, le Centre international pour la physiologie et l'écologie des insectes (icipe) recherche des répulsifs pour mouches tsé-tsé extraits de Kobus ellipsiprymnus et raffine les collar dispensers. Cependant, la mise à disposition des répulsifs pour utilisation par les agriculteurs n'est légalement pas autorisée au Kenya ; ils doivent d'abord être soumis à un essai d'efficacité par le régulateur désigné des produits antiparasitaires. Comme exigence légale avant la commercialisation, une étude a été menée pour évaluer la protection que les répulsifs produits par icipe peuvent conférer aux animaux contre la trypanosomose dans des conditions de terrain. Les essais d'efficacité ont été menés dans les collines dits Shimba Hills du Comté de Kwale au Kenya. Trois troupeaux expérimentaux traités de manière différente et répliqués, chacun avec sept animaux, totalisant 42, ont été sélectionnés pour les essais. Des pièges biconiques ont été utilisés pour surveiller les mouches tsé-tsé. Les données obtenues ont ensuite été soumises à une analyse statistique pour rechercher une éventuelle importance.

Introduction

Tsetse flies (Glossina sp.) vectors the Trypanosoma species that are responsible for Animal and Human trypanosomiasis. This disease currently threatens over 60 million people in 37 countries of sub-Saharan Africa (WHO, 2006). The threat of trypanosomiasis in livestock is a major constraint in the development of livestock sector in tsetse-infested areas, with the rural poor bearing the greatest burden due to their reliance on livestock as a form of savings and income (Fieldmann et al., 2005; Swallow, 1999; Spedding, 1981). The direct and indirect impacts of the disease include increased calf mortality rates, decreased calving rates, decreased milk and meat yields, and the disease's effect on the use of animal traction (Shaw, 2004). Animal trypanosomiasis affects 60% of livestock production in Kenya, consequently a major cause of poverty, as it leads to reduction in productivity by 20%-40% (Swallow, 2000: Hursey, 2001).

Various options have been employed in the control of animal trypanosomiasis. These include the suppression and/or eradication of tsetse populations (Jordan, 1986), the use of trypano-tolerant breeds of livestock (D'Ieteren et al., 1998), chemotherapy (Peregrine, 1994) or combinations of some or all (Holmes, 1997). Tsetse traps such as Biconical and NGU traps, use of impregnated stationary blue-black targets, mobile targets, use of synthetic pyrethroids on cattle dips and spray for animals are some of the most recent methods and tools used for control.

The most successful way to combat vector-borne diseases as suggested by Logan and Birkett, 2007 would be to shorten the lifespan of the vector, prevent or suppress the interaction between the vector carrying the pathogen and their vertebrate host. These control methods would include the use of insect repellents, trapping systems, larvicidals and insecticides among others.

Progressive science on the semio-chemicals and behaviour of tsetse flies while seeking blood meal has shed some light into attractiveness and repellence of some host to the tsetse flies. Buffaloes and cattle attract tsetse flies through production of body odour. Natural and synthetic tsetse attractants composed of constituents of buffalo and cattle urine have been widely used to attract tsetse flies to a trap or target.

Other research has revealed that tsetse flies are repelled by odour from Waterbuck (Kobus ellipsiprymnus).Waterbuck have thus enabled isolation of semio-chemicals which is responsible for the repellence properties to tsetse flies. These semio-chemicals when applied on body or dispensed from a container hang on the animal neck; confer the same repellence properties to cattle. Once the tsetse flies are repelled from biting the cattle, the animal is ultimately protected from trypanosomiasis infections in areas that are still infested. The product has no killing properties to tsetse flies.

Objective of the study

The objective of the trials was to determine the protection the ICIPE (International Centre for Insect Physiology and Ecology) Natural Blend Repellent conferred to livestock against trypanosomiasis in the field towards its registration and release to the public.

Study areaThe study was conducted in Kwale County which lies in the Southern Coast of Kenya. It is located at around 4010′28″S; 39027′37″E with the Shimba Hills National Game Reserve located centrally in the county. The reserve is protected with an electric fence to prevent wildlife escaping into the farms and surrounding villages.

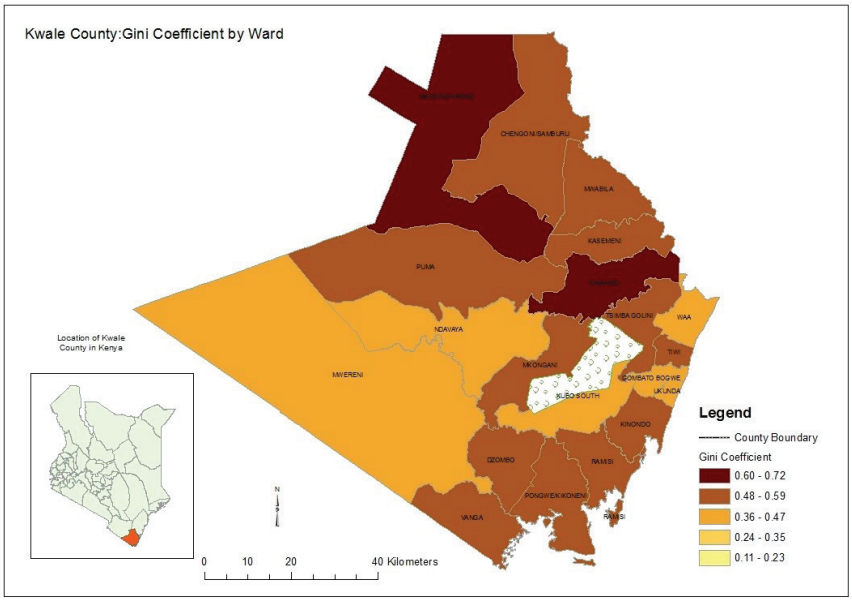


Fig 1: *Map of Kenya showing Kwale County. Source: Wikimedia.org*

The county experiences two main rainy seasons, the short rains in the months of December to February and the long rains in the months of March to June. Dry season falls between the months of August to November. The main vegetation found in the area consist of remnants of coastal tropical rain forest of species Brachystegia spiciformi, Afselia quanzensis, Chlorophora excelsa, Lannea stuhhmarnii and bushes of Latanna species. Some of the thick vegetation has given way to cultivation of crops such as maize, cassava, peas and fruit trees.

The area under study is inhabited by wildlife, among them large mammals like buffaloes (Syncerrus caffer, Sparman) and elephants (Loxodonta africana). Majority of the wildlife are confined within the parks by an electric perimeter fence. However a few animals such as bushpigs (Potamochoerus porcus) and warthogs (Phacochoerus aethiopicus, Pallas), monkeys and reptiles invade the neighbouring farms. Domestic animals kept within the homesteads are cattle, goats, sheep, cats, dogs and chicken. They are all under free-range grazing system in the farm and communal grazing areas.

In Kenya, there are eight species of tsetse distributed in most of counties (McCord, 2012). The two predominant species of tsetse flies in Kwale County are G. pallidipes, G. austeni, and G. brevipalpis while the trypanosomes are T. congolense and T. vivax (Mbahin, et al., 2008).

Materials and Methods

Animal selection

Six (6) private herd owners with homesteads located close to Shimba Hills National Reserve were identified with the help of the area Administrator and a village elder. Following physical examination of all the local zebu cattle owned by a farmer, seven (7) of them were randomly selected for the investigations per homestead. A total of 42 cattle were thus selected for the program. Two homesteads were assigned the ICIPE tsetse natural repellent contained in a collar treatment, two the standard treatment (Alphacypermethrin 10%, Dominex 100ECR sprayed on weekly basis, while the remaining two were in control group with no intervention. The age of animals was recorded according to the farmers' register while the sex was established through physical examination. The animals selected for investigations were ear tagged. Alphacypermethrin 100g/L (PCPB CR0783, batch IM-2468-008 from FMC Corporation, locally marketed by Juanco SPS Ltd) was used as the standard while the collar had the ICIPE repellent. In the control group, there were no interventions. However, in cases of trypanosome infections, the infected animals were treated with VeribenR (Diminazene aceturate).

Preparation of repellents

The repellent was obtained from the client ICIPE as a blend mixture of Guaicol 22.2%; Pentanoic acid 33.3%; Geranylacetone 11.2% and delta Octalactone 33.3%. A silicone tubing, protected from external physical damage by a metallic chamber was filled with 10ml of repellent where it diffused and dispensed into the air. The dispenser was then suspended using a rope on the collar of the 14 experimental cattle which were then left to graze freely. The status of the repellent on each cattle was monitored after every 21 days.



Photo 1: *Metallic repellent dispensers*

Trypanosome prevalence

At the on-set of the evaluation, all the cattle selected for the study were screened for trypanosomes infections. Five (5) millilitre of blood was drawn from the ear vein of each animal into heparinized tubes which were stored in a cool box at 40C. Infections were detected using Buffy coat technique (Woo, 1961) and packed cell volume (PCV) was measured. The blood tubes were centrifuged at 1200 rounds per minute for 5 minutes (Woo, 1971). All screened animals were given the initial blanket treatment against trypanosome infections using trypanocides VeribenR (Diminazene aceturate 7mg/kg). The second screening for trypanosome infection was done after 21 days and a subsequent third screening after another 21 days.

Monitoring of tsetse fly densities

To establish tsetse fly densities, Biconical traps baited with acetone and matured cow urine were deployed. The trapping sites represented the location of the control animals, the collar animals and the standard animals. Traps were deployed for 48 hours. In each site three traps were deployed; within the homestead at 50m, in the grazing field at 100m and near the perimeter fence of the park at 150m. A total of 18 traps were deployed per visit. The arrangement of the traps was to ascertain presence of tsetse flies within or near to the animal shed and in the grazing areas.

Statistical analysis

In the evaluation, the independent variables were the treatment blocks, which were three, namely, ICIPE Natural Repellent collar, standard and control. The dependent variables were the trypanosome infections and tsetse fly densities.

Exploratory data analysis (tabulation and graphical representation), regression approach and analysis of variance (ANOVA) were used to determine the density of tsetse flies at specific distances from the homestead and also estimate marginal effects of the treatments administered in comparison to the control group.

Chi-square ($\chi 2$) test was used to estimate the association between observed characteristics of different groups with respect to the proportion of infected animals.

Results

Trypanosomiasis infections in cattle

The study indicated that there were more infections at the beginning of the study in all the treatment groups. During the third visit, the group of cattle that was treated with Icipe Natural Repellent collar had very low infections incidences.

Table 1: *Infections of cattle with trypanosomes for the differing treatment groups*

Homestead and code	Code	Visit 1 (+ve or –ve)	Visit 2 (+ve or –ve)	Visit 3 (+ve or –ve)
Treatment: Icipe Natural Repellent collar: (Code ZE)	1	Tc +ve	-ve	-ve
	2	-ve	-ve	-ve
	3	Tc +ve	-ve	-ve
	4	Tc +ve	-ve	-ve
	5	Tc +ve	Tc+ve	-ve
	6	-ve	-ve	-ve
	7	-ve	-ve	-ve
Treatment: Icipe natural repellent collar: (Code ZD)	1	-ve	-ve	-ve
	2	Tc+ve	-ve	-ve
	3	Tc+ve	-ve	-ve
	4	-ve	-ve	-ve
	5	-ve	-ve	Tc+ve
	6	-ve	-ve	-ve
	7	-ve	-ve	-ve
Treatment: Standard (Alphacypermethrin 10%): (Code:ZF)	1	-ve	-ve	-ve
	2	-ve	-ve	Tc+ve
	3	-ve	-ve	Tc+ve
	4	Tc+ve	-ve	Tc+ve
	5	-ve	-ve	-ve
	6	-ve	-ve	-ve
	7	-ve	-ve	Tc+ve
Treatment: Standard (Alphacypermethrin 10%): (Code: MA)	1	Tc+ve	-ve	Tc+ve
	2	Tc+ve	-ve	Tc+ve
	3	-ve	-ve	-ve
	4	-ve	-ve	-ve
	5	-ve	-ve	-ve
	6	Tvivax+ve	-ve	Tc+ve
	7	-ve	-ve	Tc+ve

Homestead and code	Code	Visit 1 (+ve or –ve)	Visit 2 (+ve or –ve)	Visit 3 (+ve or –ve)
Treatment Control: (Code MB)	1	-ve	-ve	-ve
	2	Tc+ve	-ve	Tc+ve
	3	Tc+ve	Tvivax+ve	Tc+ve
	4	Tc+ve	-ve	Tc+ve
	5	-ve	Tc+ve	Tc+ve
	6	Tc & Tv+ve	-ve	-ve
	7	Tc+ve	Tvivax+ve	-ve
Treatment: Control: (Code MC)	1	Tc+ve	-ve	Tc+ve
	2	-ve	-ve	Tc+ve
	3	-ve	Tvivax+ve	Tc+ve
	4	-ve	-ve	-ve
	5	-ve	Tc+ve	-ve
	6	-ve	Tv+ve	Tc+ve
	7	-ve	Tc+ve	Tc+ve

Infections in control group

There was a progressive rise in infections in control herds. The changes in the mean infections during each monitoring visit rose from 3.0, 3.5 to 4.5. There were 13 (31%) infections during the three monitoring visits; one (2%) experiencing repeated infections on each visit; eight (19%) twice; and three (7%) having infections once. There were two (5%) that were never infected at any single visit. The infection at the third monitoring session was highest at 64%.

Infections in standard (Alphacypermethrin 10%) treated group

The mean infections was 2.0, 0.0 4.0 during the first monitoring, second and third visits. There was drastic drop on second monitoring and a sharp rise during the third visit. During the trial period, 12 (29%) animals experienced an infection; four (10%) of those that had infections during the first visit had a re-infection during the third monitoring though had been clean at second visit; and four (10%) had infections once and only at the third visit. The infection at the third monitoring session was 57%.

Infections in ICIPE Natural Repellent Collar group

There was reduction in mean infection for collar reference herd from 3.0 0.5, to 0.5 during the first, second and third visits respectively. There were a total

of eight (19%) infections during the entire period; one (2%) had infection only twice and six (14%) only once. A total of 6 (14%) of animals remained free of infections throughout the trial period. The infection at the third monitoring session was 7% (, Table1, Fig 2).

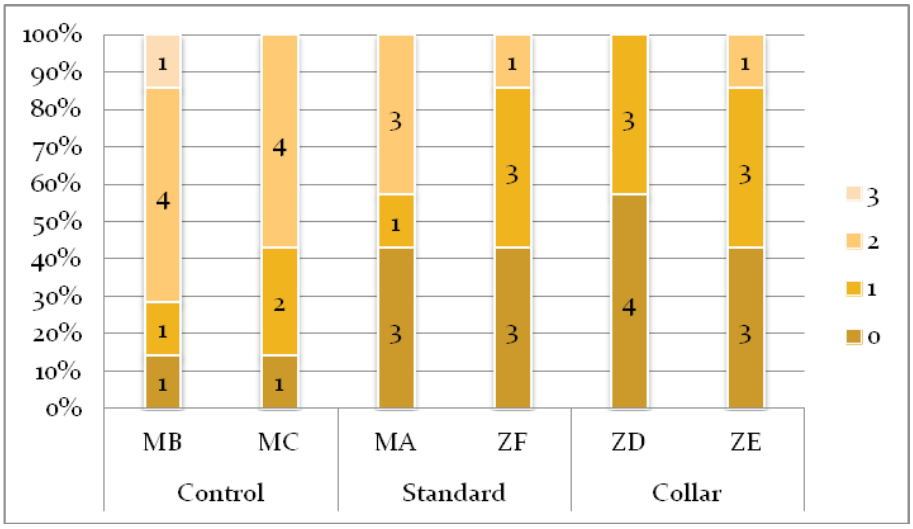


Figure 1: *Frequency of infection per cow per homestead*

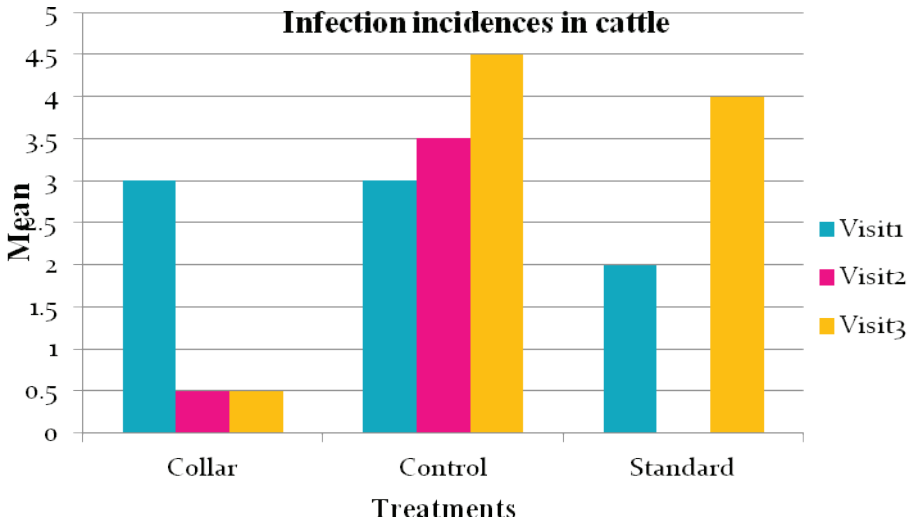


Figure 2: *Infection (mean) for the differently treated herd during each monitoring visit*

Overall response to different treatments and infections incidences

The response of cattle infections to different treatments differed significantly as presented in table 2 below, with a test of association Chi-square ($\chi 2$) (6) = 14.4143 (p = 0.025) indicating association between the treatment and cases of infections. Overall, there were about thirty three (33%) percentage of infections with 28.6 percent being Trypanosoma congolense and 4 percent Trypanosoma vivax. Only one young cattle was found to be infected with the two strains of Trypanosoma.

Table 2: *Number of cattle infection by treatment*

	Treatment (n (%))			
Infection	**Control**	**Standard**	**Collar**	**Total**
Negative	20 (47.6)	30 (71.4)	34 (81.0)	84 (66.7)
Tc +ve	17(40.5)	11 (26.2)	8 (19.0)	36 (28.6)
Tv +ve	4 (9.5)	1 (2.4)	0 (0.0)	5 (4.0)
Tc &Tv +ve	1 (2.4)	0 (0.0)	0 (0.0)	1 (0.8)
Total	**42**	**42**	**42**	**126**

Pearson chi2(6) = 14.4143 Pr = 0.025

On comparing the collar and control, the collar significantly reduced trypanosome infections by about 43 percent (p-value=0.006) while the standard treatment effectively reduced the infections by 33 percent (p-value=0.015) (Table 3). Though no statistically significant difference between standard treatment and the collar in the two treatments was observed, the collar resulted in reduced incidence rate by about 10% above the standard.

Table 3: *Differences in incidence ratio over treatment*

Treatment	**Difference**	**P>t**	**95% Conf. Interval**
Control- Standard	-0.332	0.015	-0.599, -0.065
Control - Collar	-0.431	0.006	-0.734, -0.128
Standard - Collar	-0.099	0.455	-0.360, 0.162

Tsetse fly densities

Tsetse flies were trapped in the homesteads with the highest collection having been at 150 metres further away from animal shed but nearest to the perimeter fence of the Shimba Hills National Game Reserve. The trap placed at 150 metres had an excess collection of cumulative 100 tsetse flies. The least catches were at 50meters from animal shed. Evidently, the further the trap was from the homestead, the more the tsetse fly counts were across the three treatment groups (Table 4).

Table 4: *Tsetse fly density within homesteads per 48 hours*

Treatment/Distance	Total*	Minimum	Maximum	Median	Mean
Control					
50 m	1	0	1	0	0
100 m	48	0	19	7	8
150 m	122	4	67	8	20
Total	**171**	**0**	**67**	**4**	**10**
Standard					
50 m	0	0	0	0	0
100 m	11	0	9	1	2
150 m	198	0	81	25	33
Total	**209**	**0**	**81**	**0**	**12**
Collar					
50 m	9	0	5	1	2
100 m	11	0	5	1	2
150 m	109	0	83	6	18
Total	**129**	**0**	**83**	**2**	**7**

**Figures in this column are the cumulative total of tsetse over the three visits done per homestead.*

On average, in a 48 hours trapping period, 7 tsetse flies were caught per trap within the vicinity of homesteads using collar while there were 12 and 10 caught in standard and control homesteads respectively. The density of tsetse flies was observed to increase from the 100m distance and 150m distance for all differing treatments. Generally, the collar had the least (7) mean tsetse fly densities compared to standard (12) and control (10).

The distance from the homestead, the location of the homestead (site), the treatment and the period of use of the treatment including the weather were identified to influence the tsetse fly densities. These variables were included in the analysis of variance, to determine the marginal effects of the treatment on tsetse density. The results from ANOVA eliminated the treatment factor and its period of use, while identifying distance from homestead to be significant p-value=0.0003.

Number of obs =	54	R-squared	=	0.4278	
Root MSE =	16.906	Adj R-squared	=	0.3108	

Source	Seq. SS	df	MS	F	Prob>F
Model	9403.5	9	1044.8333	3.66	0.0018
trap_dist~e	5704.4815	2	2852.2407	9.98	0.0003
site	3114.537	5	622.90741	2.18	0.0736
treatment	0	0			
visit	584.48148	2	292.24074	1.02	0.3681
Residual	12575.704	44	285.81145		
Total	21979.204	53	414.70196		

Figure 3: *Analysis of variance for tsetse density*

It was observed that the fly densities increased as one moved beyond 50 metres of the homestead. A trap set from 100 metres to 150 metres of the homestead had higher tsetse densities and this was statistically significant different (p-value=0.001), in comparison to the trap nearest to homestead (50 metres). On The tsetse densities between trap 50 metres and 100 metres was found not to be significantly different (p-value=0.557).

Discussions

Protection from trypanosomiasis infections

The present investigation reveals that collar treatment have favourable effect on the reduction of trypanosome infection by over 43 percent in zebu cattle whereas the standard was 33%. Though there may be no significant difference in infection incidences, it is observed that the collar surpassed the standard in conferring protection to cattle by a margin of approximate 10% above the standard.

The infection incidences for the collar during first examination stood at 6 (43%) animals and decreased to 1 animal (0.7%) during the third visit. On contrary the infection for the standard herd was 29% at the beginning of the study, and shot to 57% during the third monitoring visit. In the collared animals, the positive animal was a new infection while for the standard all four infected animals were re-infections having had been infected during the first visit, but cleared during the second visit and reappeared on the third visit.

The study revealed that the standard, though effective in reducing infections during the second visit, it does not continuously offer protection from high challenge of infected tsetse flies seeking blood and especially when livestock

are grazing communally in the field. Conversely, the collared animals seemed to be protected throughout during high and low exposure of tsetse flies seeking to feed as evidenced by low infections during the second and third monitoring visits.

Tsetse flies infestations

The study revealed that the tsetse densities in Kwale remain high inspite of differing treatments of the experimental herds, subjecting cattle to higher exposure to infections. The fly densities were lower in homesteads compared to the grazing areas indicating that animals are at risk within the farm and in the field. Those grazing further away from 100metres and over were more at risk.

The tsetse flies densities remained low at trap 1 and 2 for standard treatment (Alphacypermethrin 10%) treatment due to its properties of kill effect. On the other hand, for the collar treatment the densities did not differ much at any trapping point over time with tsetse flies trapped at all positions of traps. This is attributed to the fact that the collar treatment has the repellency effect on tsetse flies and not the killing effect. The study has shown that inspite of presence of tsetse flies within, the collared cattle remains free of trypanosomes. This is an indication that there is no interaction between the tsetse flies and the animals which may result in tsetse bites.

Conclusion and recommendations

It is statistically evident that both standard and collar treatments are able to keep trypanosome infections incidences low and at manageable levels. They are equally able to reduce the risks of death and loss of productivity. It is also evident that the collar repellent offers better protection from trypanosomiasis infections and its performance is not watered down by the prevailing weather. Since the collar repels the tsetse flies, other control products for killing or trapping tsetse flies should be integrated alongside the collar repellent product.

It is recommended that due to high tsetse infestations in the grazing fields bordering the game reserve and other forested areas, it would be prudent to cover more animals with the collar to reduce incidences of infections. In instances where the risk of tick-borne diseases challenge is high, use of the tick control products alongside collars would ultimately enhance the protection. Similarly, in areas where there is no risk from ticks-borne diseases, the product can be used alongside traps to mop up residue tsetse flies in the area. On zero-grazing cattle, the repellent would be the most ideal tool for protection against tsetse fly bites and infections without using any other control tool.

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APPLICATION DURABLE DE LA TECHNOLOGIE DE L'APPÂT VIVANT DANS LE CADRE DU PROGRAMME D'ÉLIMINATION DE LA MALADIE DU SOMMEIL EN OUGANDA.

SUSTAINABLE APPLICATION OF LIVE BAIT TECHNOLOGY UNDER THE STAMP OUT SLEEPING SICKNESS PROGRAM OF UGANDA

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Résumé

Depuis 2006, le consortium pour l'élimination de la maladie du sommeil encourage la technologie de l'appât vivant dans le contrôle de la maladie du sommeil en Ouganda. L'application d'acaricides / insecticides sur les bovins pour tuer la mouche tsé-tsé en utilisant les jeunes formés localement sous la supervision de vétérinaires qualifiés est toujours en cours. Waiswa et Rannalette, 2010, Waiswa et Kabasa 2010). Tout en encourageant l'approche des appâts vivants, COCTU travaille avec les structures des administrations locales, plus spécifiquement le bureau vétérinaire du district. L'équipe technique composée de vétérinaires, d'entomologistes et de chargés de l'environnement au niveau du district sont d'abord informés de l'approche afin de les familiariser davantage avec la technologie. La promotion de l'appât vivant et l'appropriation du programme par le Conseil ougandais de contrôle de la trypanosomiase contribuent grandement à réduire la transmission de la maladie du sommeil et font participer l'Ouganda dans le programme d'élimination de la maladie du sommeil ; et nous espérons atteindre cet objectif d'ici 2020. Même si cette initiative semble très prometteuse, l'Ouganda devrait régulièrement surveiller la menace de résurgence pouvant provenir principalement de zones de conservation comme les parcs nationaux et les défis transfrontaliers, en particulier à partir de la République Démocratique du Congo et du Sud-Soudan.

Abstract

Since 2006, the Stamp Out Sleeping Sickness consortium has been promoting Live bait technology in the control of sleeping sickness in Uganda where

acaricide/ insecticide application on cattle to kill the tsetse fly using the locally trained youth supervised by qualified veterinarians has been on-going (Waiswa and Rannalette, 2010, Waiswa and Kabasa 2010). While promoting the live bait approach, COCTU works with Local Government structures more specifically the District Veterinary office. The technical team comprising of Veterinary Officers, Entomologists and Environment Officers at the district who are briefed about the approach first to make them more acquainted with the technology. The promotion of live bait and ownership of the program by the Uganda Trypanosomiasis Control Council is greatly contributing to the reduction of sleeping sickness transmission and putting Uganda towards the elimination of sleeping sickness agenda and hopes to achieve this by the year 2020 are high. Much as this trend looks very promising, Uganda should regularly check the threat of resurgence that may occur mainly from the conservation areas like the National Parks and cross border challenges especially from Democratic Republic of Congo and Southern Sudan

Institutional affiliation:

Coordinating Office for the Control of Trypanosomiasis in Uganda (COCTU) isan agency under MAAIF that was established by an act of parliament 1992. Its mandate is to coordinate the human and animal tsetse and Trypanosomiasis control activities in Uganda. Its mission is to provide efficient and cost effective integrated measures aimed at eradicating the tsetse fly vector in Uganda and eliminating Trypanosomiasis from the hosts. Currently the agency has activities in about 30 in the Eastern, South-Eastern, Northern and West Nile districts.

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Background:

Since 2006, the Stamp Out Sleeping Sickness consortium has been promoting Live bait technology in the control of sleeping sickness in Uganda where acaricide/ insecticide application on cattle to kill the tsetse fly using the locally trained youth supervised by qualified veterinarians has been on-going (Waiswa and Rannalette, 2010, Waiswa and Kabasa 2010). To ensure sustainability of the use of this technology, Government of Uganda through COCTU undertook to work with the youth code named Animal Resource Key (ARK) Persons selected from sub-counties with recent history of sleeping sickness and report of presence of the tsetse vector.. The insecticide/acaricide application on cattle is combined with the treatment of cattle using Trypanocidal drugs to cleanse

the herds of the trypanosome parasites in the cattle reservoir. The method has the advantage of being cheap and attracts investment by the local livestock owners as it also has an extended benefit of controlling and reducing the burden of ticks on their livestock.

Objectives:

1. To promote community managed, community owned and community run tsetse and Trypanosomiasis control measure.
2. Contribute to the reduction of sleeping sickness and Nagana transmission.
3. To reduce the risk of merger of areas affected by T. brucei gambiense and T. bruce I rhodesiense.

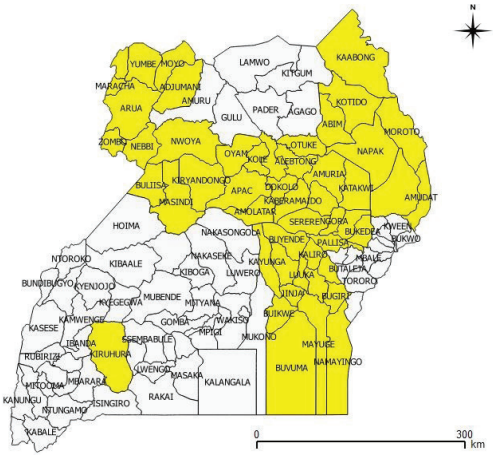
Materials:

The infrastructure available in the Local Government Veterinary Extension who are used to supervise the ARK persons on a daily basis, suitable acaricide/ insecticide containing deltamethrin as the active agent have been promoted and used, stationery, cattle for demonstration, spray pumps, protective gears and data collection tools

Areas where the technology has been promoted:

Live bait technology has been promoted in the regions of West Nile, Busoga sub region, Lango sub region, Teso sub region and Karamoja sub region all of Uganda.

Map showing the regions:



Methodology:

While promoting the live bait approach, COCTU works with Local Government structures more specifically the District Veterinary office. The technical team comprising of Veterinary Officers, Entomologists and Environment Officers at the district are briefed about the approach first to make them more acquainted with the technology.

Together, the team determines the tsetse and Trypanosomiasis hotspots in their district and develops a selection criterion for the youth to be involved. The animal population per Sub County is used to determine the number of youth needed to carry out the work. Each sub county is allocated a number. The District Veterinary Office then uses the selection criterion to select the youth to be trained in live bait technology. The youth are trained, equipped and commissioned to start the work of spraying in their respective sub counties.

Each trained youth is given 100mls bottle of deltametharin as starting stock costing about 14,000/= per bottle. The youth spray farmers' animals at a cost agreed upon between the service provider and the farmer. The cost per animal sprayed ranges between 500- 1,000/= depending on the area and negotiations. This means the youth will earn between 30,000/= to 50,000/= per bottle. If they take off the cost of deltametharin the balance is the profit.

The youth are provided with data collection sheets where they record the details of cattle owners and number of animals sprayed per household. The filled sheets are submitted to the veterinary office monthly who also forwards them to COCTU to consolidate and analyze the data.

COCTU promotes catalytic approaches for a period between 3- 6months to create awareness and interest the farmers and the youth. During this period, COCTU pays cost of spraying 50 animals per youth per month. The youth are encouraged to spray one cattle per farmer as a demonstration in areas where farmer uptake is slow and COCTU meets the cost the catalytic spraying those animals. The farmer will realize the changes on the spayed animal and next time will be willing to pay for all their animals.

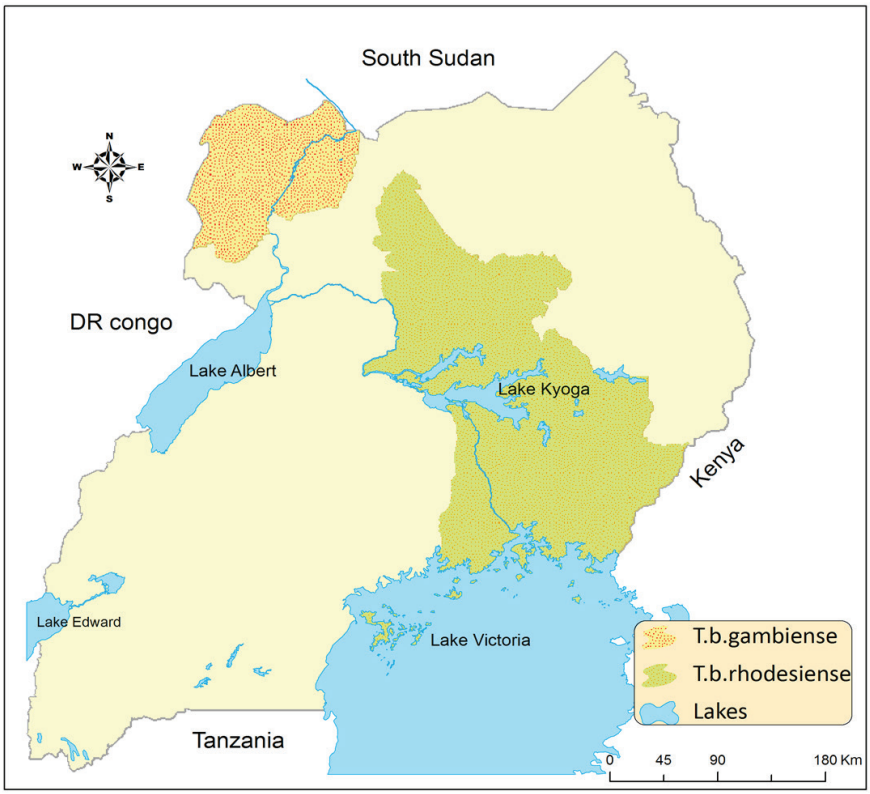
COCTU pays each youth 25,000/= per month for the 50 cattle spayed for free as demonstrations to farmers during the catalytic period. There after the system moves by itself sustainably as the youth spray the cattle at a fee.

For sustainability, the supply chain of the delatmethrin is managed by the

private sector like the 3V Vet Franchise that was a product of the SOS approach (Waiswa and Rannalette, 2010). Youthful veterinary graduates are encouraged to open drug shops in the localities where the technology is being promoted to supply and advise the youth carrying out the spraying. The drug shops become the sources of the quality acaricide for the youth spraying after the end of the six months.

Results and discussion:

1. Veterinarians have opened up drug shops in areas where the technology is being promoted. This has helped farmers to access not only the quality acaricide/insecticide, but also medicines for other animal diseases. It has also created a good rapport between the farmers and veterinarians. Shops have been opened in Dokolo, Kaberamaido, Otuke, Kole, Oyam, Maracha, Nebbi, Amolator, Apac, Iganga, Luuka and Mayuge districts.
2. The technology has created employment for about 500 youths. They spray animals at a fee and they used the proceedings to look after their families, purchase goats for raring, open up land for crop production and some have used the money to go back to school and study. Socially, the youth feel more useful to their communities because of their contribution to animal welfare and controlling of tsetse and Trypanosomiasis.
3. The communities have understood and appreciated their roles and responsibilities in the control of tsetse and Trypanosomiasis. Previously, the communities used to think there is totally nothing they can do in the control as than reporting and waiting for government to come and intervene.
4. The sleeping sickness cases have been reducing over years from 477 cases in 2005 to 2 cases in 2017.
5. The risk of the merger of the Tbr and Tbg that was seriously threatening in 2005 is now greatly being reduced by the use of live bait technology approach.



Conclusion:

The promotion of live bait and ownership of the program by the Uganda Trypanosomiasis Control Council is greatly contributing to the reduction of sleeping sickness transmission and putting Uganda towards the elimination of sleeping sickness as a constraint to human health by the year 2020 are high. Much as this trend looks very promising, Uganda should regularly check the threat of resurgence that may occur mainly from the conservation areas and neighboring countries.

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SOCIO-ECONOMICS, LAND USE AND ENVIRONMENT / SIOCIOÉCONOMIE, UTILISATION DES TERRES ET ENVIRONNEMENT

LA TRYPANOSOMOSE COMME CONTRAINTE A LA PRODUCTION CAPRINE EN ZAMBIE : UN EXAMEN DES INFORMATIONS DISPONIBLES RESULTANT DES RECHERCHES PAR RAPPORT AUX PERSPECTIVES D'AUGMENTATION DE LA PRODUCTION CAPRINE

TRYPANOMOSIS AS A CONSTRAINT TO GOAT PRODUCTION IN ZAMBIA: A REVIEW OF AVAILABLE RESEARCH BASED INFORMATION IN RELATION TO PROSPECTS FOR INCREASED GOAT PRODUCTION

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Résumé

La trypanosomose transmise par la mouche tsé-tsé est une contrainte majeure à la production de ruminants en Afrique. Bien que l'impact de la maladie soit largement associé aux bovins, des infections naturelles par des trypanosomes parasitaires se produisent chez les chèvres voire chez les moutons. La manifestation clinique de la trypanosomose est rarement observée chez ces petits ruminants, en particulier les chèvres, et ceci semble avoir contribué à la croyance commune des éleveurs selon laquelle ces animaux tolèrent efficacement l'infection à trypanosome et, en tant que tel, ils pensent que la maladie ne les affecte pas. Les résultats de la recherche indiquent que l'infection à trypanosome pourrait entraîner des effets négatifs importants sur la reproduction et, partant, sur la productivité caprine. En Zambie, environ 37% de la superficie terrestre est infesté de mouches tsé-tsé, de sorte que, selon le niveau de risque d'infection par la trypanosomose, l'élevage bovin est généralement appuyé par une utilisation efficace des trypanocides, et en l'absence de ces médicaments il n'est pas réalisable du tout. Dans la plupart de ces régions, les agriculteurs se tournent vers l'élevage de caprins qu'ils considèrent comme la meilleure espèce alternative de ruminants.

Les informations disponibles indiquent qu'il existe actuellement une demande accrue de caprins sur le marché local et international, ce qui implique que la production caprine pourrait contribuer beaucoup plus à la création de revenus, à l'amélioration des moyens de subsistance et au développement rural. Le document examine les informations disponible (issues des travaux de recherche) sur la production caprine et la

Abstract

Tsetse-transmitted trypanosomosis is a major constraint to ruminant livestock production in Africa. Although the impact of the disease is largely associated with cattle, natural infections with parasitic trypanosomes do occur in goats and sheep as well. Clinical manifestation of trypanosomosis is rarely observed in these small ruminants, particularly goats, and this appears to have contributed to the common belief among farmers that these animals do effectively tolerate trypanosome infection and as such the disease does not affect them. Research findings indicate that trypanosome infection could lead to significant negative effects on reproduction and hence productivity in goats. In Zambia, about 37% of the land area is tsetse infested such that, depending on level of risk to infection with trypanosomosis, rearing of cattle is usually either sustained through effective use of trypanocides or it is not feasible at all. In most such areas, farmers turn to rearing of goats as the best alternative ruminant livestock species. Indications are that there is currently increased demand for goats in the local and international market, and this entails goat production could contribute much more to income generation, improved livelihoods and rural development. The paper provides a review of available research based information on goat production and trypanosomosis in general and in the context of Zambia, with particular reference to tsetse infested areas in the country. Prospects and recommendations for improved/increased goat production in relation to trypanosomiasis, through particular interventions, are proposed and discussed.

1.0 INTRODUCTION

Trypanosomiasis, a disease that is transmitted by tsetse-fly (Glossina morsitans morsitans, or G. pallidipes), is a major constraint on ruminant livestock production in Africa, Asia, and South America and has a profound influence on productivity of domestic animals (FAO, 2000).

The status of trypanosomiasis in goats in Africa, Asia, and South America was described by Gutierrez et al (2006) in their review of the current status of the disease in Africa, Asia, and South America, its mode of infection, clinical manifestations, diagnosis and treatment of the different parasites in goats. Natural infections with Trypanosoma congolense, T. vivax, T. brucei, and T. evansi have been described in goats and the role of goats in the epidemiology of trypanosomiasis is largely discussed, although it is not yet well-understood or clearly documented in Zambia. According to scientific findings, earlier assumptions were that trypanosomiasis presents a subclinical pathway and that goats do not play an important role in the epidemiology of the disease. However, this assumption is currently undergoing a critical review because goats themselves may also serve as a reservoir of trypanosome infection for other animal species, including human beings in the case of T. brucei

rhodesiense (Bealby et al., 1996).

Zambia land area size is 752,614 km2 and 37% (or 278,467 km2) of this land area is tsetse-infested. The areas that are of high potential for goat production in Zambia also have high tsetse infestations, predominantly with Glossina morsitans morsitans, G. pallidipes species. The fact that goats are known to have adaptive ability to thrive even in very harsh environmental conditions, most farmers may not be aware that a disease like trypanosomiasis can adversely affect the productivity of goats. Majority of smallholder farmers in Zambia are not able to directly or indirectly relate the low productivity of their flocks to effect of trypanosomiasis. The country is making every effort to increase production and improve productivity of goats, in order to produce surplus to meet the needs for both local and export markets. Prevention and treatment of trypanosomiasis in goats can help to improve the production and productivity of goats and farmers can ultimately realize more economic returns from goat farming.

1.1 Rationale

Goat and sheep production is gaining socio-economic importance in Zambia, not only as source of livelihood for majority of people in the country, but also because of the rising demand for goats and sheep on the international market. In terms of goat population, there are currently about 4.8 million goats in Zambia, most of which are reared by rural communities country-wide. There are very few large commercial and smallholder farmers engaged in goat production. Goat rearing is concentrated in Southern (with over 1.6 million), Central (1.3million) and Eastern (0.87 million) Provinces – which are the areas of high tsetse infestations.

Goats are raised by the smallholder farmers is under the semi-intensive system where animals are confined in night shelters and, during the day, the goats are left to feed freely in and around the farmland or at a nearby communal land (IAPRI, unpublished). The Zambian Government has recognized that increasing the efficiency of small ruminant production is one of the means of poverty-reduction and commercial goat production can contribute not only to improving household food and nutritional security but is also a potential source of export earnings. The rising increase in market demand for goats, both locally, in the sub-Sahara region and on the international market calls for improved and sustained goat productivity. In view of this, there is a need to enhance the dissemination of information research-based findings, through review of available information on the impact of animal trypanosomiasis on goat production in the country and other parts of Africa.

1.2 Objectives of the Review

The purpose of this review of available information from past research is to bring out important findings about the impact of trypanosomiasis on goat production for dissemination to all stakeholders, with focus on the Zambian situation.

Specific objectives of this information review are:

1. To share available research information on the effect of trypanosomiasis on goat production, with focus on the prevailing situation in Zambia;
2. To get a better understanding of the effect of trypanosomiasis on the productivity of goats, especially under smallholder production systems;
3. To identify gaps in the available information and disseminate useful research findings to farmers, to help them recognize and appreciate the effect of trypanosomiasis on goats production and productivity;
4. Based on the identified and shared information gaps, make recommendations and propose more areas for investigation (or research) and interventions; and
5. To share information on possible interventions for reduced negative impact of trypanosomiasis on goat production in Zambia.

2.0 APPROACH TO INFORMATION REVIEW

The process of data review was undertaken in form of a desk study and evaluation of empirical data and findings from past research work conducted on issues bordering on the effects of tsetse and trypanosomiasis on goat production in Zambia. The study largely focused on the works conducted at Kakumbi Tsetse Research station between 1989 and 1992. The review involved critical examination of available key findings pertaining to effect of trypanosomiasis on goat production, with focus on the Zambian situation. Wider reference was also made to relevant scientific findings from other parts of Africa with similar production systems or environmental conditions, such as Tanzania and Kenya.

3.0 HIGHLIGHTS OF RESEARCH FINDINGS

3.1 General findings

Signs or effects of trypanosomiasis are shown by various animals in many forms. Although anaemia is recognized as the most important clinical manifestation of animal trypanosomiasis, trypanosomal infections in goats are sometimes difficult to detect because of the low parasitaemia (the quantitative content of parasites in the blood) that occurs. Consequently, control measures

have not commonly been applied. Other available reports revealed that chemo-prophylactic treatment of goats in a tsetse-infested area of southern Tanzania had improved productivity goats significantly (Hendy 1988).

This review mainly focuses on the research work done by staff at Kakumbi Tsetse Research Station over a four-year period (1989 to 1992). During the four-year experimental period from July 1988 to February 1993, the researchers tried to establish, among other things:

- Whether goats of the local breed were affected by trypanosomiasis
- Clinical disease conditions which occurred in goats
- mortality rate in goats attributed to trypanosomiasis
- effect of trypanosomiasis on growth rate in goats
- impact of trypanosomiasis on fertility in the female goats
- significance of the information to goat producers, especially those who are living in tsetse-infested areas in Zambia
- the kind of advice that could be given to farmers in order to improve goat production

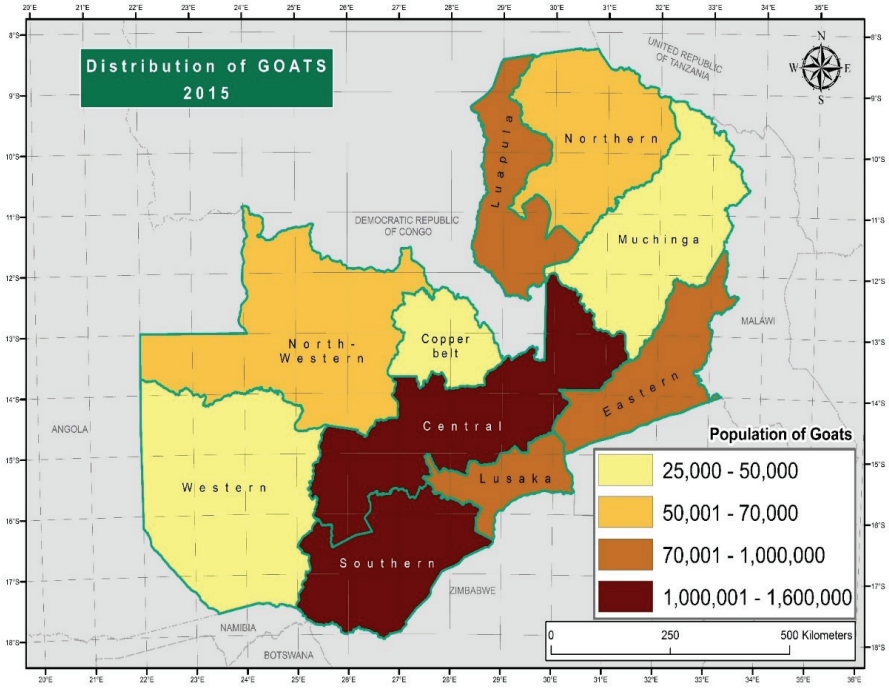
As reported by Bealby et al (1996), these research findings reveal that:

a. Goats can be infected with most common species of trypanosomes (for example, Trypanosoma brucei, T. congolense and T. vivax. All three species were found to be common at Kakumbi (Mfuwe area, Mambwe district), as may be the case in most tsetse-infested areas of Zambia (Fig 1).

b. local breed of goats which were transported from tsetse-free areas to the tsetse-infested area in the Luangwa Valley were affected by trypanosomiasis. However, it is also likely that most other breeds of goats could succumb to this disease, either noticed or unnoticed.

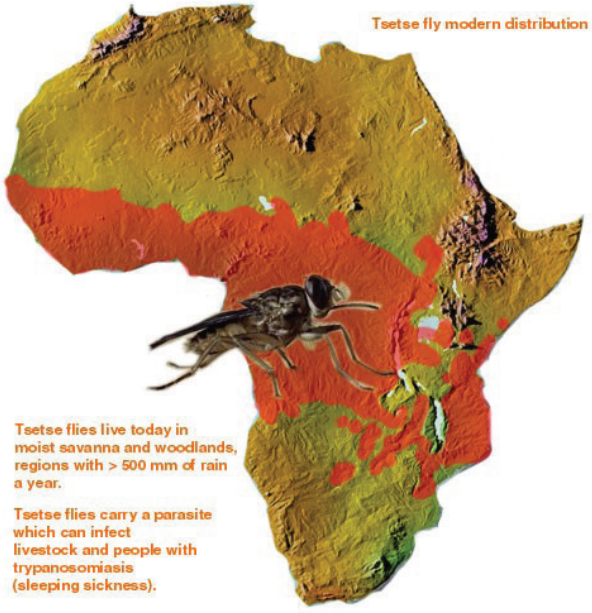
c. older goats were more susceptible to the effects of trypanosomiasis than younger goats and goats born under tsetse challenge may have developed a degree of protective immunity against the effects of trypanosomiasis.

d. tsetse challenge was related to the incidence of trypanosomal infections in naïve goats that were exposed to tsetse challenge, although the prevalence of trypanosomal infections in goats varied from year to year (seasonal effects).



Source: *Ministry of Fisheries and Livestock (MFL) 2015 Annual Report*

Fig 2: *Distribution of Tsetse and prevalence of trypanosomiasis in Africa*



Source: Adapted based on image from www.wüstenschiff.de

3.2 The Tsetse Challenge

In order to have an insight of the effects of trypanosomiasis on goat and sheep production in Zambia, it is necessary to highlight a few aspects of the disease vector – the Tsetse. Tsetse 'challenge' was derived, separately for each of two of the species caught, Glossina morsitans morsitans, G. pallidipes, as the product of tsetse 'apparent' density, which gives an index of tsetse apparent density relative to the availability of tsetse. Glossina pallidipes was an important vector of trypanosomiasis in the Luangwa Valley and, despite that Glossina morsitans morsitans might have been as important, they were less availability and fewer tsetse were caught.

3.3 Incidence and prevalence of trypanosomal infections

In line with findings by Peregrine et al (1988), incidences of new infections in goats were detected, based on the patterns of trypanosomal parasitaemia of goats in the control or unprotected flock, in which goats were not protected with trypanocides (Isometamidium Chloride or Samorin). Comparing weekly incidences of infections between protected and unprotected goats in the four experiments, it was assumed that, at a dose of 0.5 mg/kg body weight, Samorin gave significant protection for 12 weeks (Peregrine et al 1988). If a goat was not retreated with Samorin at the end of this period, it was included in the unprotected group for the purpose of calculating the weekly incidence of trypanosomal infections. 'Weekly incidence' in this case describes the rate of acquisition of new infections observed in any one week. 'Prevalence' refers to the proportion of animals detected as being infected in any one week, regardless of when an animal first became infected. To be considered 'infected' an animal needed to be found to be parasitaemic. Although infections also occurred at other times of the year, the results of these experiments showed that the highest risk of trypanosomiasis infection was between July and October (calendar weeks 31 to 44), while the prevalence of trypanosomal infections in unprotected goats rose after tsetse challenge increased. The determination of trypanosome prevalence has been found to be particularly problematic in goats and sheep, especially where (and if) some degree of trypano-tolerance exists in these animals, as reported by Hendy (1988). Detection of trypanosomes in the blood may then be difficult, because parasitaemias were transient (or temporary) and of low intensity.

3.4 Effects of trypanosomiasis on productivity of goats

3.4.1 The role of genetics and environment

The broad genetic variability of African livestock breeds enables them to exist under harsh environmental conditions of all kinds, including trypanosomiasis infestation, if the challenge is not too high (Jahnke, et al. 1982). Environmental pressure continues to maintain a wide range of resistance aptitudes within

all breeds and may be regarded as a genetic response of the species to the risk of trypanosomiasis infection. In controlled environments such as research stations or experimental farms, most African goat breeds show good performance aptitudes in live body weight and fertility. This suggests that goats would react very well towards any improvement in their management conditions, especially if the goats are not subjected to significant nutritional stress or disease conditions. Local goat breeds are able to make the best use of their actual environment, and, with better management, performance can be improved (Jahnke, et al. 1982).

3.4.2 General effect on goat performance and production

Like any other disease that affects vascular system, trypanosomiasis can limit productive and reproductive performance of goats. The disease can contribute to unnecessary goat mortalities, reduction in fertility in females, low birth-weights of kids and metabolic waste in general. This will negatively impact on profitability of goat production enterprise. Reduced effects of trypanosomiasis could significantly contribute to increased food production from ruminant livestock. Table 1 below presents food production of ruminant livestock in tropical Africa.

Table 1: *Food production of ruminant livestock in tropical Africa (1986).*

Livestock Species	**Livestock product**	**Quantity ('000 ton)**	**Grain-equivalents ('000 ton)d**	**Calorific value (Mcal/ ton)**
Cattle	Meat[a]	2,245	8,980	6,286
	Milk[b]	6,451	10,967	2,193
Goats	Milk[c]	2,294	3,900	780
Sheep	Meat	917	3,668	2,568
Total		**n.a.**	**27,515**	**11,827**

Source: Jahnke et al (1982)

Notes: [a]The meat commodity is defined as indigenous meat (FAO). [b]The milk commodity is defined as whole, fresh milk. [c] FAO (1986a) [d]Conversion ratios for grain and calorific equivalents are taken from Jahnke (1982)

In terms of food production from ruminant livestock, Jahnke et al (1982) estimated that there would be an increase of 16% meat and 14% milk production by both cattle and small ruminants per year as a result of the eventual disappearance of trypanosomiasis. The potential benefits from trypanosomiasis control/eradication would appear to be considerable.

3.4.3 Mortality of goats and growth of flock size

In terms of working towards increasing productivity of goats among smallholder farmers, very little progress has been made in most parts of Africa, particularly Zambia. The disease risks associated with raising kids (young goats) are very high and, in some cases, kid mortality rates of 40% are common. This was supported by works done by Sumberg and Mack (1985) who found that increased mortality (particularly that of kids), low growth rates and reduced fertility, attributed to trypanosomiasis, limits production and lowers productivity in goats. Therefore, there is a need to reduce the mortality rate in order to improve goat productivity.

The results of the four-year research work at Kakumbi revealed that trypanosomiasis caused the death of 42% of untreated goats. Deaths in the unprotected flock followed a relatively short illness of only a few weeks which was characterised by a rapidly developing anaemia, fever and weight loss. The mortality in untreated goats, attributed to trypanosomiasis infections, was alarmingly high (42% goats died), confirming that trypanosomiasis significantly contributed to deaths of goats in the flocks which were not treated with trypanocides. However, trypanosome-infected goats responded well to chemo-treatment and this effectively prevented deaths which could have caused by trypanosomiasis. The treatment also reduced the severity of the animal losses.

Mortalities of the goats in the unprotected flock led to actual reduction in the numbers of goats which translated into stagnation of the flock size. The same researchers found an annual increase of 50% in flock size of protected female (using Samorin), compared to 30% when the Does were not protected against trypanosomiasis. The zero growth in the flock size of the untreated group well demonstrated the negative impact of trypanosomiasis, contradicting the common observation that 'goats apparently thrive under tsetse challenge'. On the other hand, no mortalities due to trypanosomiasis were recorded in goats which were treated with trypanocides. The chemical protection against trypanosomiasis (as chemo-prophylaxis) effectively prevented deaths from occurring, as a result of trypanosomiasis infections.

3.4.4 Impaired reproductive performance in does

In the experiments at Kakumbi, the fertility of a female goat was defined to be impaired if:

i. no kid (young goat) was born. This was found in 4 out 10 goats

ii. kids were conceived after the second mating, not the first, or

iii. kids were born prematurely and were stillborn or died within four days of birth (recorded in one goat). Twins needed to be both dead for the dam to be included in this category.

Based on the above definitions, untreated goats had the lowest fertility, whereby stillbirths and abortions were associated with parasitaemias in late pregnancy. This was attributed to increased trypanosomal infections following the seasonal increase in tsetse challenge, just before kidding. High infections with trypanosomiasis was recorded in untreated goats before their deaths in late pregnancy. With regard to parity, the oldest (parity 3) goats were more frequently parasitaemic during pregnancy throughout the experiment compared with parity 1 and 2 goats. Trypanosomiasis infection induces loss of body condition in pregnant animals leading to birth of young with low birth-weights, foetal and neonatal losses, besides production losses in lactating animals.

Table 2: *Conception rates in Does*

Proportion of adult goats that conceived (%)	
Protected dam	Unprotected dam
79	57

Prevention of trypanosome infections using chemoprophylaxis maintained high levels of fertility, with 91% of protected Does (female goats) kidding successfully over the three years. Female goats which were not treated with trypanosomes had a 28 per cent reduction in in conception rates (Table 2), while loss of body condition in pregnant does led to lower kid birth weights (Table 3) and resulted into 62 per cent more still births. Some studies also revealed that reproductive health of bucks is adversely affected by trypanosomal infections (Luckins, 1992).

3.4.5 Birth weight and growth of kids

Although subsequent growth rate of kids was similar, regardless of whether the dam was protected against trypanosomiasis or not, kids from 'protected' dams had higher birth weights on average than those from 'unprotected' dams. It was observed at Kakumbi that the mean body weights at birth and 20 weeks of age were lower in 1991 by 11% and 32% in 1989 and 1990.

Table 3: *Birth weight of Kids in protected compared to unprotected (kg) does*

Birth weight of Kids (kg)	
Protected dam	**Unprotected dam**
1.85	1.69

3.4.6 Effect of trypanosomiasis in relation to nutritional status of goats

Past research has shown that the effect of trypanosomiasis was more severe in goats which were under-nourished. Due to the fact that trypanosomiasis occurs mostly in the dry season, as reported by Mochabo et al., (2005), there is a likelihood that goats (and sheep) may succumb more to the effect of trypanosomiasis. In Zambia, especially under extensive (free-range) low-cost goat production systems, goats are usually on low plane of nutrition during the long (6-8 months) dry season when feed is scarce and of low quality in most parts of the country. During this period, goats that are under-nourished and rarely receive adequate feed supplements.

Faye et al (2005) found out that tryps-infected goats (caused by T. vivax) which had not received feed supplements (i.e. depended on basal diet) for a long period lost more weight than those which were supplemented. This was due to a marked (13 -24%) reduction in feed intake, as was supported by Dam et al (1997). This clearly shows that although good nutrition does not by itself provide protection against trypanosomiasis, the effects of the disease are less severe in better-nourished animals, and that adequate nutrition enhances the ability of trypanosome-infected animals to withstand the adverse effects of infection.

3.5 Approaches to management of Trypanosomiasis in Goats

Trypanosomiasis acts as an environmental constraint, makes large rangeland areas unsuitable for most ruminant livestock production and, in particular, reduces productivity of goats. On the other hand, trypanosomiasis control, treatment or eradication is expensive and is only justified if the benefits (weighted by the risks) exceed the costs. Jahnke et al (1982) recommended that it is important to make an informed decision when choosing from available options for addressing this challenge, such as tsetse control or eradication, use of chemical treatment or prophylaxis in goats. Where areas affected by tsetse challenge are large and cannot be isolated, making it hard to completely eradicate tsetse, the only option will be vector (Tsetse) control. Chemical prophylaxis or treatment can be integrated in tsetse control methods.

Studies from various parts of Africa illustrate the relationship between human populations and populations of the morsitans group of tsetse, where the G.

morsitans occupy the savanna woodlands of Africa (often suitable locations for domestic livestock). These species of tsetse feed readily on cattle, sheep and goats and form the basis of the trypanosomiasis challenge (Jordan, 1986). In such areas (including most parts of Zambia), vector control, as opposed to vector eradication, can play a very important role and would be more cost-effective for reducing the level of trypanosomiasis problem in goats.

4.0 CONCLUSION

The available research-based information reveals that trypanosomiasis is a serious constraint on goat production, increasing mortality and reducing fertility. These two effects reduce flock growth and potential offtake and availability of meat, milk and skins. Under village conditions (inappropriate goat farming practices), trypanosomiasis has adverse effects on goats which negatively impacts on people's food and nutritional security and this ultimately impedes their socioeconomic development.

Trypanosomiasis limits production and lowers productivity in goats, attributed mainly to increased mortality (particularly in kids), low growth rates and reduced fertility levels. Losses due to mortalities is probably the biggest constraint to increased productivity and profitability of goats (Sumberg, J. E. and Mack, S. D., 1985). Several interventions such as through cost-effective use of trypanosomes alongside with best practices for flock management can significantly reduce the adverse effects of trypanosomiasis in goats.

The use of trypanocides as a chemical prevention measure in goats can effectively reduce the incidence of trypanosomal infection, reduce losses of goats through mortalities and can improve conception rates. This can ultimately lead to positive flock growth and overall increase goat productivity.

Feed supplementation is very important and can have beneficial effect in goats which are exposed to tsetse challenge or likely to be trypanosome-infected during pregnancy (Reynolds and Ekwuruke, 1988). Giving feed supplements to goats during the long (6 - 8 months) dry season, especially under extensive (free-range) low-cost goat production systems can reduce the effects of trypanosomiasis in goats.

Although goats have proved to thrive well in most agro-ecological environments in Zambia, the negative effects of Trypanosomiasis on the productivity of goats have not yet been recognized and appreciated by most goat farmers in Zambia. This may attributed to lack of knowledge or inadequate application of extension methodologies for effective management of trypanosomiasis in

goats. There is serious inadequacies in the delivery of livestock extension and veterinary services to create awareness about the impact of trypanosomiasis on goat production. This is exacerbated by utter negligence (lack of attention) by frontline staffs to trypanosomiasis in small ruminants, as was revealed by a study in the southern part of Zambia by Nyimba, et al. (2015). Trypanosomiasis is therefore considered to be one of the Neglected Diseases.

5.0 RECOMMENDATIONS AND WAY FORWARD

Given the information and key findings from research work conducted both in Zambia and other parts of Africa, specific management approaches and interventions are required to reduce the effect of trypanosomiasis on goats to contribute to improved productivity of the animals.

5.1 Trypanosomiasis management

Use of prophylaxis (preventive chemical treatment) on goats during pregnancy, is recommended. There is need to:

a. enhance access by farmers and animal health service providers to affordable trypanocides (e.g. Samorin), especially at village level;

b. have skilled staff at all times to assist farmers in administering trypanocides and avoid possible faulty drug administration which may render the chemical prophylaxis ineffective;

c. develop more skills among staff in the treatment of individual goats during pregnancy with practical of knowledge about mating patterns and breeding systems.

5.2 Improved Flock Management

As we consider the above recommendations, there is need pay close attention to key aspects of goat husbandry and application of research information:

a. Improved nutritional plane

   Reduced feed intake in goats (sheep) is common under low-cost extensive goat management systems. Interventions should include supplementary feeding to minimize metabolic waste (improving body condition of goats/ sheep) during acute and chronic trypanosomiasis.

b. Knowledge and skills transfer

i. Use of appropriately packaged available research-proven information and dissemination of the information acquired from research in order to have a better understanding of the real situation of trypanosomiasis in Zambia.

ii. training and building capacity of farmers (especially smallholder goat farmers) in order to enable them demonstrate to themselves and their peers the best goat management practices;

iii. create more awareness among smallholder farmers and staff about the impact of trypanosomiasis (as a 'silent' disease) on goat productivity and the subsequent income losses that can occur in the flock as a result of trypanosomiasis.

5.3 Investing in result-oriented research

There is very little documented research in Zambia on the epidemology, control and management of trypanosomiasis in goats. There is therefore need to

a. development results-oriented research programmes to further:

i. investigate the control of the parasitaemia and anaemia in to contribute to the survival of goats from trypanosomiasis.

ii. study the effect of trypanosomiasis in relation to nutrition (body condition) of goats under specific management conditions

b. strengthen research-extension linkages in order make research results be more relevant to the socio-economic needs of farming communities and be able to address key aspects of environmental sustainability.

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IMPACT DU CONTRÔLE DE LA MOUCHE TSÉ-TSÉ ET DE LA TRYPANOSOMIASE SUR LE REVENU DU MÉNAGE DANS L'ILE DU COMTÉ DE LAMU, AU KENYA

IMPACT OF TSETSE AND TRYPANOSOMIASIS CONTROL ON HOUSEHOLD INCOME IN PATE ISLAND OF LAMU COUNTY, KENYA

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Résumé

La campagne panafricaine d'éradication de la mouche tsé-tsé et de la trypanosomiase (PATTEC), le gouvernement du Kenya et les communautés agricoles de l'île de Pate, dans la côte nord du Kenya, ont participé à la lutte contre les mouches tsé-tsé et à la maladie qui se propage dans le bétail. L'impact des interventions dans l'île n'a cependant pas été quantifié, ce qui rend nécessaire la réalisation de cette étude. L'objectif de l'étude était d'évaluer l'impact de la lutte contre la tsé-tsé et la trypanosomose sur le revenu du ménage dans l'île de Pate, dans le comté de Lamu, au Kenya. L'étude a appliqué une méthode d'échantillonnage aléatoire proportionnelle pour dessiner un échantillon de 254 ménages agricoles de Pate Island où des interventions ont été menées et 282 ménages agricoles des divisions Amu et Hindi du comté où l'initiative PATTEC n'avait pas été mise en oeuvre. En utilisant des questionnaires structurés administrés par le biais d'entretiens ménagers, l'étude a recueilli des données socioéconomiques, y compris les caractéristiques du ménage, la production de bétail (bovins, moutons, chèvres, ânes et volailles), la propriété des biens durables et les conditions de vie dans le ménage.

Les résultats préliminaires ont caractérisé les ménages selon différentes méthodes de lutte contre la tsé-tsé et la trypanosomose qu'ils ont appliquées et le type d'actifs durables détenus, y compris le bétail dans les zones de projet

et autres. En utilisant l'analyse de composante principale (PCA), l'indice de richesse des ménages serait construit comme un résultat pour mesurer le bien-être des ménages du projet par rapport aux ménages non-projets dans le comté de Lamu, au Kenya.

Mots clés : Impact, Tsé-tsé, Trypanosomiase, Pauvreté

Abstract

The Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC), the Government of Kenya and the farming communities in Pate Island in the Northern coast of Kenya have been participating in the control tsetse flies and the disease that it spreads in livestock. The impact of the interventions in the island had however not been quantified making it necessary to carry out this study. The objective of the study was to evaluate the impact of tsetse and trypanosomiasis control on household income in Pate Island of Lamu County, Kenya. The study applied proportional random sampling method to draw a sample of 254 farm households from Pate Island where interventions were carried out and 282 farm households from Amu and Hindi divisions of the county where the PATTEC initiative had not been implemented. Using structured questionnaires administered through household interviews, the study collected socio-economic data including household characteristics, livestock (cattle, sheep, goats, donkeys and poultry) production, ownership of durable assets and living conditions in the household.

Preliminary findings have characterized households by different tsetse and trypanosomiasis control methods that they applied and the type of durable assets owned including livestock in project and non-project areas. Using Principal Component Analysis (PCA), the household wealth index would be constructed as an outcome to measure the well-being of project households versus non-project households in Lamu County, Kenya.

Key words: Impact, Tsetse, Trypanosomiasis, Poverty

Introduction

Tsetse flies (Glossina spp) transmit a fatal zoonotic disease called trypanosomiasis. The disease is known as sleeping sickness in humans and nagana in livestock. Tsetse flies infest 37 sub-Saharan African countries covering approximately 9 million km2 and threaten about 60 million people and 48 million cattle (WHO, 2001). It is one of the greatest constraints to agricultural development in the sub-humid and humid zones of Africa. Sleeping

sickness was under control in Africa during the 1960s and 1970s. However, the last two decades have seen the disease spread to epidemic proportions due to the breakdown of control programmes causing a public health crisis in many affected areas (Smith et al., 1998). If the goal of poverty reduction and food security is to be achieved, this major constraint to rural development needs to be removed.

To address the problem, African Heads of State and Government collectively launched the Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) project in 2000 with a view of guiding the process of eradicating tsetse flies and trypanosomiasis (T&T). As part of this initiative, the African Union PATTEC (AU-PATTEC), the African Development Bank (AfDB) and the governments of affected countries prepared a proposal for a Pan-African programme, the Eradication of Tsetse and Trypanosomiasis in Sub-Saharan Africa (ETTSSA), as well a proposal for the first phase of the eradication campaign (AfDB, 2004). Six countries participated in the Phase I Project, three countries in West Africa (Burkina Faso, Mali and Ghana) and three others in East Africa (Ethiopia, Kenya and Uganda).

In Kenya, the area infested by tsetse is estimated to be 138,000 square kilometers covering 38 out of 47 counties (KENTTEC, 2011). The disease impoverishes livestock farmers and threatens food security and livelihoods. The risk of human sleeping sickness outbreak is high in the Lakes Victoria and Bogoria basins and the Mara Serengeti tsetse belt all with a total human population of about 11 million people at risk of infection (KENTTEC, 2011; KNBS, 2010). The first phase of PATTEC-Kenya project was implemented from 2005 to 2011 covering a total area of 24,000 square kilometres in three tsetse belts namely Lake Victoria basin, Lake Bogoria and Meru/Mwea. The control of tsetse and trypanosomiasis in Pate Island served as a pilot project in the Coastal tsetse belt in an area of approximately 62 square kilometres with control starting in 2010. The direct achievements of tsetse and trypanosomiasis eradication interventions under the PATTEC-Kenya programme include reduction of tsetse fly populations and reduced disease prevalence in cattle and in humans (KENTTEC, 2009; 2011; 2012; 2013; 2014; AfDB, 2011). The impact of these changes on income and wellbeing of households had not been quantified. It was therefore important to understand the impact of the project on poverty for governments to roll out tsetse and trypanosomiasis eradication campaign to other tsetse infested areas which had not been covered by such a programme. This study therefore seeks to estimate the wealth index of the project and non-project households in Lamu County

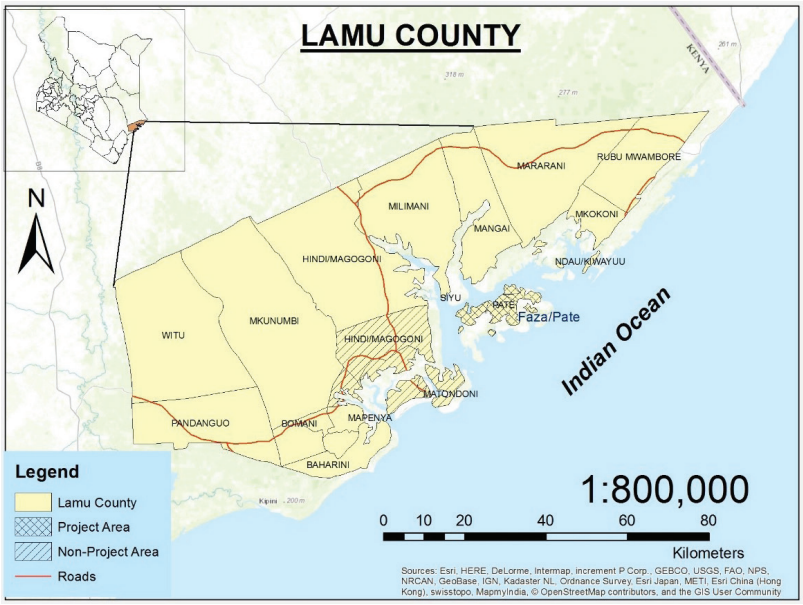
Research methodology

The Study area

Pate Island is located in the Indian Ocean along the Northern Coast of Kenya in Lamu County lying between latitude 1°40, 20° 30 S and longitude 40° 15 and 40° 35 East (GoK, 2013). The Pate Island is the largest Island in the Lamu Archipelago, which lie between the towns of Lamu and Kiunga, close to the border of Kenya and Somalia. There are two administrative divisions in the Island namely Faza and Kizingitini (GoK, 2013).

The Island has a total area of 92.9 square kilometers of which the agricultural farm land area is about 60 square kilometres. The Island had a livestock population of about 8,150 heads of cattle, 6,250 goats and 3,200 donkeys. The Lamu East sub-county of Lamu County where the study area is situated enjoys two rainy seasons and temperatures ranging between 230 and 320 C throughout the year. The long rainy season comes in April and May and ends by June while the shorter rainy season from November and December. The main economic activities in the island include agriculture, livestock keeping and marine activities with the residents being predominantly Muslim.

The study site was selected because of being an isolated area which served as a control for the interaction between the project area and the adjacent areas where there were no project inputs. The flow of resources between the project area and non-project areas was naturally restricted reducing the confounding effects. For example, if livestock from non-project households had access to the project area grazing lands where insecticide treated targets were deployed and livestock had been sprayed with insecticides, the benefits would spill over to the non-project households which is the control group. Map 2.1 gives a picture of the study area.



Source: *Author*

Map 2.1: *A Map showing the study areas of Pate Island, Amu Island and Hindi division of Lamu County, Kenya*

Sampling

Sample size determination

The number of farm households practicing livestock rearing in the two Islands and in Hindi division was obtained from the extension reports of the County Government of Lamu. According to Kothari and Gaurav (2014) the formula which is applicable in the case of a finite population is given as:

$$n = \frac{z_{\alpha/2}^2 N\sigma^2}{(N-1)e^2 + z_{\alpha/2}^2\sigma^2} \quad \text{.....(2.1)}$$

where

n is the size of the sample

N is the size of population

e is the acceptable estimation error given by

σ is the standard deviation of the population

$Z_{\alpha/2}$ is the critical value using the N(0,1) distribution for confidence level

In this study, the sample size was computed using the above stated formula at a Confidence level of 95% and a margin of error of 5%. The population of project households was 734 and that of non-project households 959. With the critical value $Z_{\alpha/2} = 1.96$ and $\sigma = 0.5$, the sample size for the project households was determined as:

$$n = \frac{1.96^2 * 734 * 0.5^2}{(734-1)0.05^2 + 1.96^2 * 0.5^2} = 252.4 \simeq 253$$

and the sample size for the non-project households was:

$$n = \frac{1.96^2 * 959 * 0.5^2}{(959-1)0.05^2 + 1.96^2 * 0.5^2} = 274.5.9 \simeq 275$$

Sample selection

The sample of project households was drawn from the tsetse and trypanosomiasis controlled area of Pate Island. The area covers eight administrative sub-locations namely Kwatini, Kwatongani, Pate, Siyu, Shanga, Tchundwa, Kizingitini and Myabogi all with different number of households owning livestock. The village roads were used as transects along which proportional samples were systematically drawn from each village until a total of 253 households was obtained for the non-project households. The first household along each transect was randomly selected. There after every 5th household with livestock was selected for interviewing. The sample of non-project households was drawn from Amu division and Hindi division of Lamu County where the Kenya Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) had not commenced tsetse and trypanosomiasis control interventions. The sub-locations covered in Hindi division were Hindi, Bargoni, Mokowe and Kilimani while those covered in Amu division were Matondoni, Kipungani, and Manda. Households with livestock in the non-project area were sampled following the same sampling protocol adopted for the households in the project area. A total of 275 non-project households were selected and interviewed.

Data collection

Using structured questionnaires administered through household interviews, the study collected socio-economic data including household characteristics, livestock (cattle, sheep, goats, donkeys and poultry) production, ownership of durable assets and living conditions in the household.

Indicators of household welfare

There are various indicators of welfare that may be used as outcomes to gauge impacts of a program. Baker (1960) considers poverty measures including head count index, poverty gap index, squared poverty gap and Watts's index. The head count index measures the proportion of the population living in households with income per person below the poverty line while the poverty gap for each household is the difference between the poverty line and the household income (Ravallion, 1994). The two methods are however not distribution sensitive. Some distribution sensitive measures include squared poverty gap where individual poverty gaps as a proportion of poverty line are squared before taking the mean and Watts index which is the mean of log of the ratio of the poverty line to income (Atkinson, 1987).

According to Deaton (1997), expenditure-based economic status indicators have been found to be more reliable than indices that are income based. The main reason is the relatively high non-response rate for income based measures as well as under or over reporting typically found in income items utilized in standard of living household surveys.

Filmer and Pritchett (2001) popularized the use of Principal Component Analysis (PCA) for estimating wealth levels using asset indicators to replace income or consumption data and concluded that PCA provides plausible and defensible weights for an index of assets to serve as proxy for wealth. Asset-based measures depict an individual or a household's long-run economic status and therefore do not necessarily account for short-term fluctuations in economic well-being or economic shocks. This study estimated the wealth index as an outcome for the assessment of impact of tsetse and trypanosomiasis control. Cordova (2008) points out that the indicator together may tap a long term dimension of economic well-being of the households.

Constructing the household wealth index

The wealth index (WI) is a composite index composed of key asset ownership variables. The WI is normally used as a proxy indicator of household level wealth. This was calculated using the Principal Component Analysis (PCA) method performed on variables which are indicators of wealth among the farm households in Lamu County, Kenya. The following indicators of wealth were adopted from those used in a number of Demographic and Health Surveys (DHS):

Table 2.1: *Indicators of wealth among households*

Asset	Rich household	Poor household
Whether household owns these assets or not		
Land	1= Yes	0= No.
TV	1= Yes	0= No.
Radio	1= Yes	0= No.
Mobile phone	1= Yes	0= No.
Bicycle	1= Yes	0= No.
Car or Boat	1= Yes	0= No.
Motorcycle	1= Yes	0= No.
Cattle	1= Yes	0= No
Improved cattle	1= Yes	0= No
Donkeys	1= Yes	0= No.
Goats	1= Yes	0= No.
Dairy goats	1= Yes	0= No
Sheep	1= Yes	0= No.
Poultry	1= Yes	0= No.
Type of dwelling unit		
Roofing material	1= Iron sheet or Tiles	0= Makuti or Grass thatch
Walling material	1= Bricks or Stone	0= Mud, lime or Timber
Floor material	1= cement	0= dust

Source: Author

The estimation of relative wealth using PCA is based on the first principal component concept. Following the example of Cordova (2008), the study expressed the wealth index (WI) for farm household i in Lamu county as:

$$y_i = \alpha_1\left(\frac{x_1 - \bar{x}_1}{s_1}\right) + \alpha_2\left(\frac{x_2 - \bar{x}_2}{s_2}\right) + \dots\dots\dots + \alpha_k\left(\frac{x_k - \bar{x}_k}{s_k}\right) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2.2)$$

where:

γ_i is the wealth index for Lamu county farm household i.

χ_1 , χ_2 ...... χ_κ is a vector of asset variables which include ownership of land, television set, radio set, mobile phone, bicycle, a car or boat, motorcycle, cattle, donkeys, goats, sheep, poultry; whether roofing material is made of thatch or iron sheets, whether walling material is made of stones or mud, whether floor material is made of cement or earth).

χ_1 , χ_2 ..... χ_κ are means of assets χ_1 , χ_2 ..... χ_κ respectively

S_1 , S_2 ..... S_κ are the standard deviations of assets χ_1 , χ_2 ..... χ_κ respectively

$\propto_1$, $\propto_2$ ..... $\propto_\kappa$ are weights for each variable χ_κ for the first principal component.

The procedure yielded a wealth index for every sampled household in the project area and the non- project area. Using the calculated wealth index, households were categorized into quintiles of wealth where quintile 1 = Very poor household, 2 = Somehow poor, 3 = Middle, 4 = Wealthy and 5 = Very wealthy household.

Results and discussions

The household wealth indicator variables included for the study were whether household owned assets such as bicycle, boat or car, cattle, dairy goats, donkeys, goats, improved cattle, land, mobile phone, motorcycle, poultry, a radio set, sheep and a television set. The materials used on the floor, roof and walls of the household dwelling were also included as indicators of wealth in the study area. All the variables were first dichotomized as 1=Yes and 0=No as suggested by Vyass and Kumaranayake (2006) to indicate the ownership of each household asset. The findings on general asset ownership in the study area are presented in subsections 3.1 to 3.3.

Livestock ownership

It was found that 64 percent of the households owned indigenous cattle while the remaining percent did not. Of all the households interviewed, only 3 percent of had improved cattle compared to 97 percent who did not have. When asked about ownership of donkeys, 24.8 percent of the households owned donkeys while the remaining 75.2 percent did not have. On the ownership of indigenous goats, the study found that 49.6 percent owned indigenous goats while the remaining 50.4 percent did not have. It was found that 2.6 percent of the households had dairy goats as opposed to the remaining 97.6 percent who did not have. Households were asked whether they owned poultry or not; in response 47.8 percent said they owned poultry while 52.2 percent did not own poultry. Finally the study found that only 8.6 percent owned sheep while 91.4 percent did not. The results are presented in Table 3.1.

Table 3.1: *Livestock ownership in Pate, Amu and Hindi divisions of Lamu County*

Type of livestock	Ownership of livestock	Frequency	Percent	Cumulative Percent
Indigenous Cattle	No	193	36.0	36.0
	Yes	343	64.0	100.0
	Total	536	100.0	
Improved cattle	No	520	97.0	97.0
	Yes	16	3.0	100.0
	Total	536	100.0	
Donkeys	No	403	75.2	75.2
	Yes	133	24.8	100.0
	Total	536	100.0	
Indigenous Goats	No	270	50.4	50.4
	Yes	266	49.6	100.0
	Total	536	100.0	
Dairy goats	No	522	97.4	97.4
	Yes	14	2.6	100.0
	Total	536	100.0	
Poultry				
	No	280	52.2	52.2
	Yes	256	47.76	100.0
	Total	536	100.0	
Sheep	No	490	91.4	91.4
	Yes	46	8.6	100.0
	Total	536	100.0	

Source: *Author: Household Livestock ownership survey report.*

Ownership of other assets

The study's investigation on the ownership of other assets revealed that 17 percent of the households owned bicycles while 83 percent did not have; 6.9 percent owned either boat or car yet the remaining 93.1 percent did not; 78.9 percent owned agricultural land while 21.1 percent did not. Asked whether they owned mobile phones or not, 84.1 percent of the households said they had phones while 15.9 percent said they did not. The study further found that 69.4 percent of the households owned radio sets while 30.6 percent did not; 30.6 percent owned televisions while 69.4 percent did not and finally, only 13.8 percent owned motorcycles while 86.2 percent did not. The findings are presented in Table 3.2.

Table 3.2: *Household ownership of other assets in Pate, Amu and Hindi divisions of Lamu County*

Asset	Ownership of asset	Frequency	Percent	Cumulative Percent
Bicycle	No	445	83.0	83.0
	Yes	91	17.0	100.0
	Total	536	100.0	
Boat or car	No	499	93.1	93.1
	Yes	37	6.9	100.0
	Total	536	100.0	
Land	No	113	21.1	21.1
	Yes	423	78.9	100.0
	Total	536	100.0	
Mobile phone	No	85	15.9	15.9
	Yes	451	84.1	100.0
	Total	536	100.0	
Radio set	No	164	30.6	30.6
	Yes	372	69.4	100.0
	Total	536	100.0	
Television set	No	372	69.4	69.4
	Yes	164	30.6	100.0
	Total	536	100.0	
Motorcycle	No	462	86.2	86.2
	Yes	74	13.8	100.0
	Total	536	100.0	

Source: Author: *Household ownership of other assets survey report.*

Materials used for household dwelling

The study found that 39 percent of the households had the floors of their houses made of dust (earth floors) while the remaining 61 percent had floors made of cement; 52.1 percent of the households had roofs of their dwelling units made of naturally available materials such as makuti or grass thatch while 47.9 had their roofs made of iron sheets. Of all the households, 59 percent had the walling material for their dwelling units made of naturally available materials including mud, rough stones, lime or timber while 41 percent had the walls made of either bricks, quarry stones or cement. The results are presented in Table 3.3.

Table 3.3: *Materials used on household dwellings in Pate, Amu and Hindi divisions of Lamu County*

Dwelling unit	Material used	Frequency	Percent	Cumulative Percent
Floor material	Dust	209	39.0	39.0
	Cement	327	61.0	100.0
	Total	536	100.0	
Roofing material	Makuti or grass thatch	279	52.1	52.1
	Iron sheets or tiles	257	47.9	100.0
	Total	536	100.0	
Walling material	Mud, rough stones, lime or timber	220	41.0	41.0
	Brick, quarry stones, cement	316	59.0	100.0
	Total	536	100.0	

Source: *Author: Characteristics of household dwelling survey report.*

Constructing the household wealth index

The response of households on the dichotomized wealth indicator variables was captured in the Statistical Package for Social Scientists (SPSS) and Microsoft Excel spread sheet. Principal Component Analysis (PCA) procedure was used to calculate the factor scores from the first principal component. The PCA assigns weights to different assets owned by the households giving rise to Relative Wealth Indices for all households both in the PATTEC project area and non-project areas.

Quintiles of wealth in Pate Island, Amu and Hindi divisions of Lamu County

Using the household wealth indices obtained from the PCA procedure, households were categorized into quintiles of wealth where quintile 1 = Very poor household, 2 = Somehow poor, 3 = Middle, 4 = Wealthy and 5 = Very wealthy household. The household quintiles of wealth were cross tabulated by whether household was in project area or not. The results of the cross tabulation revealed that 0.7 percent of households in the study area were very poor and found in the project area compared to 19.2% percent of households who were very poor and found in non-project area. It was also found that 16 percent of households in Lamu were categorized as very wealthy and found in the project area compared to 3.7 percent who were very wealthy and found in non-project area. The results of household quintiles of wealth are presented in Table 3.4.

Table 3.4: *Quintiles of Wealth among farm households in Lamu County, Kenya*

Household category		**Percentile Group of the HH wealth index**					
		Very Poor	**Somehow poor**	**Middle**	**Wealthy**	**Very wealthy**	**Total**
Non-project households	Count	103	85	54	20	20	282
	%	19.2	15.9	10.1	3.7	3.7	100.0
Project households	Count	4	21	55	88	86	254
	%	0.7	3.9	10.3	16.4	16.0	100.0
Total	Count	107	106	109	108	106	536
	%	20.0	19.8	20.3	20.1	19.8	100.0
Mean Wealth index		-1.5103	-0.5992	0.1368	0.73014	1.23921	0

Source: Author: *Household wealth index report*

The Propensity Score Matching (PSM) estimator

The Project households and non-project households were matched on their propensity scores calculated using pre-project underlying covariates which included age of the household head, sex of the household head, ownership of land, other major source of livelihood for the household, and years of education of the household head. The steps of calculating the PSM estimator were followed as suggested in literature (Stuart & Rubin, 2007; Caliendo & Kopeinig, 2008; Rosenbaum & Rubin, 1985, Lechner, 2001). One to one matching algorithm was applied to come up with 140 project households and 136 non-project households.

The mean wealth index for households that did not participate in the tsetse and trypanosomiasis control project was subtracted from that of project households. The mean wealth index for project households was 0.698793 (Std. Err. = 0.0476051) compared to -0.745156 (Std. Err. = 0.0772896) for the non-project households resulting to a PSM estimator of 1.4439. These results are presented in Table 3.5.

Table 3.5: *Mean Household wealth index in project and non-project areas*

Household category	Number of households	Mean Household Wealth Index	Std. Deviation	Std. Error Mean
Project households	140	0.698793	0.5632709	0.0476051
Non-project households	136	-0.745156	0.9013444	0.0772896
PSM Estimator		1.443949		

Source: *Author: Mean household wealth index report*

Comparison of mean household wealth index

Using an independent samples t-test, the mean wealth index for project households was 0.698793 (Std. Err. = 0.0476051) compared to -0.745156 (Std. Err. = 0.0772896) for the non-project households. The wealth indices of the two categories of household were found to be significantly different at F=28.395. This suggests that the tsetse and trypanosomiasis control activities that were carried out in Pate Island led to an increase in household wealth. The t-test results are indicated in Table 3.6.

Table 3.6: *Independent Samples Test*

Levene's Test for Equality of Variances		T-test for Equality of Means					95% Confidence Interval of the Difference	
F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
28.395	.000			.000	1.44	.090	1.27	1.62
		15.907	225.359	.000	1.44	.091	1.27	1.62

Discussion

The PSM estimator obtained in this study means that there was a rise in household wealth index by 1.4439. This suggests that the tsetse and trypanosomiasis control activities that were carried out in Pate Island led to an increase in household wealth. The durable assets such as bicycle, boat or car, land, mobile phone, radio set, television set, motorcycle was a proxy for the medium to long term stream of income in the households during the project period. The control of tsetse flies and the elimination of disease transmission in Pate Island may have resulted to increased livestock numbers and quality.

Conclusion and recommendations

Conclusion

The proportion of very wealthy households of Lamu County was higher in the project areas than in non-project areas resulting in a rise in Wealth Index among Pate Island households implying that the households had higher incomes conserved over time in durable assets such as livestock, bicycles, boats or cars, land, mobile phones, radio sets, television sets, motorcycles and in improved living conditions.

Recommendations

1. Mobilize resources among governments and development partners to eradicate tsetse and trypanosomiasis in vast land areas of Africa which are still heavily infested by Tsetse flies. This study has demonstrated that investments in tsetse and trypanosomiasis control pays off. The findings can be used for resource mobilization to enable implementation in other areas affected by tsetse flies hence poverty alleviation among beneficiary communities.
2. Design studies to assess impact of tsetse and trypanosomiasis control in areas which are not geographically isolated. The pate Island study was a case of an intervention area surrounded by water serving as a natural barrier. This was an ideal situation separating the treatment group from the control group of households' hence minimal infiltrations of project output into the non-project area.
3. Governments, public agencies and non-governmental organizations (NGO) to design tsetse eradication activities according to existing needs and constraints.

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ANNEXES

ANNEX 1: COMMUNIQUE

THE 34TH CONFERENCE OF THE INTERNATIONAL SCIENTIFIC COUNCIL FOR TRYPANOSOMIASIS RESEARCH AND CONTROL (ISCTRC) AND THE 16TH PATTEC COORDINATORS MEETING

LIVINGSTONE, ZAMBIA, 11-15 SEPT 2017

The 34th ISCTRC Conference and the 16th PATTEC Coordinators' meeting was held at the AVANI Victoria Falls Resort in Livingstone, Zambia between the 11th and 15th of September 2017. The Conference theme was, 'Capitalizing on the progress made against human and animal trypanosomiases– the way forward in partnership with all stakeholders'. The conference was officially opened by the Minister for Fisheries and Livestock, Hon. Michael Katambo on behalf of His Excellency Mr. Edgar Changwa Lungu, President of the Republic of Zambia. The keynote address was presented by the Director of Rural Economy and Agriculture, African Union Commission, Dr Godfrey Bahiigwa on behalf of the Commissioner, H.E. Mrs. Josefa Sacko. In this key note address, it was acknowledged that a lot of work has been done during the past 68 years of combating tsetse and trypanosomiasis (T&T) and it is now time to review the substantial progress made in terms of institutional arrangements, research, available technologies, approaches, partnerships, investments and lessons learned in order to bring the tsetse fly vector and trypanosomiasis under control in Africa.

The Director of AU-IBAR, Prof Ahmed Elsawalhy elaborated on the objectives of the 34th ISCTRC Conference and the 16th PATTEC Coordinators meeting which are; to review, T&T, control technologies, strategies and policy options; to Identify gaps in research and control and to make recommendations for T&T Research and control for the next two years. He thanked His Excellency Mr. Edgar Changwa Lungu for the commitment of his Governments in the fight against human and animal trypanosomiasis.

The opening ceremony was also graced by the Honourable Minister for Southern Province, Hon. Dr. Edify Hamukale; the Deputy Mayor representing his Worship the Mayor of Livingstone, Councilor Eugene Mapuwo; their Royal Highnesses, the Traditional Leaders; the Permanent Secretary for Fisheries and Livestock, Dr. David Shamulenge and the Principal Secretary, State Department of Livestock in the Republic of Kenya, Dr. Andrew Tuimur. In his opening remarks, the Minister highlighted the impact of tsetse and trypanosomiasis on rural development and human welfare on the African continent and called for concerted efforts to ensure total removal of the tsetse fly from the continent.

The conference was attended by 301 participants from 34 African countries and beyond. The presentations focused on the following thematic areas: The Pan African Tsetse and Trypanosomiasis Campaign (PATTEC); Human African Trypanosomiasis (HAT); Animal African Trypanosomiasis (AAT); Tsetse Biology and Control and Socio-Economics, Environment and Land Use. Keynote addresses were delivered under each of the thematic areas; and symposia were held with a focus on emerging themes such as tsetse and parasite genetics/genomics/proteomics.

During this meeting one hundred and fifteen (115) scientific presentations were made, ninety (90) of which were presented orally while twenty five (25) were presented as posters. Twenty seven (27) African countries presented their reports on progress of tsetse and trypanosomiasis activities since the last ISCTRC Conference held in Ndjamena Chad in the year 2015.

The inclusion of T&T control and elimination strategies and programmes into national development plans was highlighted as critical for the resource mobilization and sustainability of the fight against T&T.

The Conference appreciated the efforts made by National, Regional and International Organizations in ensuring access by the disease endemic countries to appropriate tools for tsetse and trypanosomiasis interventions. The elimination of HAT and the progressive control of AAT appear today as achievable and necessary goals, and they should be supported by all stakeholders in a coordinated manner.

It was recognized that the training and mentoring of young scientists was crucial in addressing the growing manpower demands of tsetse and trypanosomiasis research/control. In this regard the meeting appreciated the efforts of organisations that have supported capacity building and appealed to others to contribute to this noble effort.

The meeting observed with great concern the widespread occurrence of counterfeit drugs and/or drug misuse and the resultant phenomenon of treatment failure. The general consensus was that all relevant stakeholders should work more closely with the relevant government arms to address the crisis in the shortest possible time.

The meeting appreciated the efforts made by scientists to generate new knowledge and tools that are appropriate in the planning of control/eradication programmes and advocated for their validation and adoption

Historical perspectives, the mandate and functions of the AU-IBAR/ISCTRC were presented and discussed. The meeting recommended the strengthening of the council to enable it respond to emerging challenges and new technological advancements.

The status of T&T elimination in Africa with respect to gains registered, challenges, lessons learned, best practice and future perspectives was presented and discussed.

The meeting made a number of recommendations that require implementation. To this end, the conference deliberations will be brought to the attention of the meeting of Specialised Technical Committee (STC) of Ministers in charge of Agriculture, Rural Development, Water and Environment on October 5 and 6 2017 organized by the African Union Commission in Addis Ababa, Ethiopia.

Participants expressed their gratitude to the Government and people of Zambia for accepting to host the meeting and for the warm hospitality that they received.

COMMUNIQUE

34EME CONFERENCE DU CSIRLT LIVINGSTONE, ZAMBIE, 11-15 SEPTEMBRE 2017

Le CSIRLT a tenu sa 34ème Conférence générale à l'AVANI Victoria Falls Resort à Livingstone en Zambie, du 11 au 15 septembre 2017.

La Conférence a été officiellement ouverte par Son Excellence Monsieur Katambo, ministre de la Pêche et de l'Elevage, au nom du Président de la République de Zambie. Cette rencontre a également été honorée par la présence de membres de la famille royale. Dans son discours liminaire, le ministre a mis en évidence l'impact de la mouche tsé-tsé et de la trypanosomiase sur le développement rural et le bien-être humain au niveau du continent africain. Il a exhorté les scientifiques à se concentrer sur les domaines de recherche susceptibles de contribuer au contrôle effectif de la mouche tsé-tsé et de la trypanosomiase.

Les exposés ont porté essentiellement sur les domaines thématiques suivants : la campagne panafricaine de lutte contre la mouche tsé-tsé et la trypanosomiase ; la trypanosomiase humaine africaine ; la trypanosomiase animale africaine ; la biologie et le contrôle des glossines ; la socioéconomie, l'environnement et

l'utilisation des terres. Des exposés thématiques ont été présentés dans chacun des domaines précités, et des symposiums ont été organisés, avec un accent particulier sur les thèmes émergents.

Au cours de cette réunion, cent quinze (115) exposés scientifiques ont été présentés. Quatre-vingt-dix (90) documents ont été présentés par voie orale tandis que vingt-cinq (25) étaient sous forme de posters. Dix-sept (17) pays africains ont présenté leurs rapports sur l'état d'avancement des activités de lutte contre la mouche tsé-tsé et la trypanosomiase menées depuis la dernière conférence du CSIRLT tenue à Ndjamena au Tchad en 2015.

L'intégration des stratégies et programmes de contrôle et d'élimination des T & T dans les plans nationaux de développement a été soulignée, car elle est considérée comme cruciale pour la mobilisation des ressources et la durabilité de la lutte contre les T & T.

Les participants à la réunion ont salué les efforts déployés par les organisations internationales dans le but de s'assurer que les pays endémiques ont accès aux bons outils pour les interventions de contrôle de la mouche tsé-tsé et de la trypanosomiase. L'élimination de la THA et le contrôle progressif de la TAA apparaissent aujourd'hui comme des objectifs réalisables et nécessaires, et ils devraient être soutenus par toutes les parties prenantes de manière coordonnée.

Les participants ont reconnu que la formation et le mentorat de jeunes scientifiques sont essentiels dans la mesure où ils permettront de répondre aux besoins croissants en main-d'œuvre dans les domaines de la recherche et du contrôle de la mouche tsé-tsé et de la trypanosomose. À cet égard, les participants à cette réunion se sont félicités des efforts déployés par les organisations ayant apporté un appui au renforcement des capacités, et ont lancé un appel à d'autres entités pour solliciter leurs contributions.

Les participants à la Conférence ont noté avec une grande préoccupation l'apparition généralisée de médicaments contrefaits et / ou l'usage abusif de médicaments et l'échec de traitement qui en résulte. Le consensus général était que le secteur privé devrait travailler plus étroitement avec les services gouvernementaux concernés pour faire face à cette crise dans les meilleurs délais possibles.

Les participants à cette rencontre ont salué les efforts déployés par les scientifiques dans le but de générer de nouvelles informations et outils qui

seront très utiles dans la planification des programmes de lutte et d'éradication.

Les participants ont discuté de la mission et des fonctions du CSIRLT et ont adopté une résolution qui réclame un renforcement du Conseil qui lui permettra de relever les défis émergents.

Les participants à la réunion ont formulé un certain nombre de recommandations qui doivent être mises en œuvre. À cette fin, les travaux de la Conférence seront portés à l'attention des ministres au cours de leur réunion qui sera organisée les 5 et 6 octobre 2017 à Addis-Abeba en Éthiopie.

Les participants ont exprimé leurs remerciements à l'endroit du Gouvernement et du Peuple de la Zambie pour avoir accepté d'abriter la réunion et pour le chaleureux accueil qu'ils leur ont réservé.

ANNEX II PRESS RELEASE, 34TH GENERAL CONFERENCE OF THE INTERNATIONAL SCIENTIFIC COUNCIL FOR TRYANOSOMIASIS RESEARCH AND CONTROL (ISCTRC)

Tsetse-transmitted African trypanosomiasis is a devastating disease for humans and livestock. The disease is characterized by intermittent fever, anemia, loss of body condition (and hence weakness), reduced productivity and, often high mortality. In terms the disease's negative impact on farmers, particularly the traditional and small-holder farmers, trypanosomiasis is considered the most important among the livestock diseases that affect the country – i.e. in terms of priority livestock diseases in the country, it is ranked second only to Anthrax.

The 34th General Conference of the International Scientific Council for Tryanosomiasis Research and Control (SCTRC) is organized by the African Union and the Ministry of Fisheries and Livestock

The theme is "Capitalizing on the progress made against human and animal trpanosomiasis-the way forward in partnership with stakeholders"

ISCTRC is a statutory Council of the African Union Commission established in the early 60s as a vehicle to promote international cooperation in the fight against trypanosomiasis. Membership includes: Africa Union Member States, Africa Union Pan African Tsetse and Trypanosomiasis Eradication Campaign, International organizations, including FAO, WHO and the IAEA

The conference

The conference is scheduled to take place in Livingstone, Zambia at Avani Hotel, from 11th to the 15th September, 2017 and the objective is promoting information sharing on tsetse, human and animal trypanosomaisis problem, review, control strategies and recommend appropriate approaches in research and control.

The key Note Speaker during the official opening of the conference will be AUC Commissioner of Rural Economy and Agriculture, H.E Josefa Leonel Correia Sacko, top government officials, FAO/PAAT/WHO, IAEA, ILRI, ICIPE, FIND, DNDI and officers from ISCTRC.

300 participants from the 36 affected African countries and international organizations are expected to attend the 5-day conference, with over 100

scientific papers being presented. Research emanating from ISCTRC scientific community is providing new information for smarter methods of tsetse and trypanosomiasis control. Five traditional leaders from the five provinces of Zambia where the disease is prevalent will be in attendance.

34th General Conference of the International Scientific Council for Tryanosomiasis Research and Control (ISCTRC) opens at 08:00 on Monday 11th September 2017 at Avani Hotel in Livingstone. The 1st session will commerce with statements by officials followed keynote speaker initial address.Session 2 with feature the Key note Presentation by Pro. Ahmend Elsawaihy, James Wabacha and Solomon Haile Mariam with the theme "68 years Journal as a vehicle to promote international cooperation in the fight against T&T. Session 3a and 3b will discuss the theme on PATTEC imitative and country paper.

The concurrent sessions of the 34th ISCTRC will start on Tuesday on 12th September, 2017 and will feature Session 3c under the theme PATTEC imitative and country report, then session 4a on Epidemiology and session 4b on Diagnosis and treatment and conclude the day on session 4c on Symposium.

On Wednesday 13th September 2017 will be session 4d and session 4e will be on Control and Surveillance Strategy. These will cover a wide range of topics on control and strategies of trypanosomiasis. Session 5a will be on Epidemiology, a keynote presentation and discussions, then session 5b on Diagnosis and discussions.

On Thursday 14th September 2017 will feature session 5c on Chemotherapy and drug resistance and session 6 on poster presentation. Session 7a Biology the theme is Glossina Biology, Control and Eradication with a key note presentation and conclude the day with 7b on interactions with the environment.

On Friday 15th September, 2017 will be paper presentation, followed by session 7c on Symposium: New Insight from Tsetse Biology for Evidence based HAT Control, then session 8 under theme 5 on Land Use Environment and Socio-economics. Session 9 will conclude the conference with recommendations and closing ceremony.

Expected Outputs and Outcomes

- Tsetse and Trypanosomiasis information shared and disseminated
- Networking amongst the tsetse and trypanosomiasis research and control workers enhanced
- Participants exposed to better control approaches
- Recommendations for tsetse and trypansosmiasis research and control activities for the next two years adopted
- Capacity for tsetse and tsetse and trypansosmiasis reseach and control workers enhanced
- Visibility of African Union Interafrica Burearu for Animal Resource and international Scientific Council for Trypanosomiasis Research and control enhanced.
- Conference proceedings
- The Visibility and the role of Governement of Zambia in the fight against tsetse and trypansosmiasis in Africa enhanced.

Released by

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